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AERONAUTICAL ENGINEERING

A Continuing Bibliography

Supplement 102

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in October 1978 in

- *Scientific and Technical Aerospace Reports (STAR)*
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INTRODUCTION

Under the terms of an interagency agreement with the Federal Aviation Administration this publication has been prepared by the National Aeronautics and Space Administration for the joint use of both agencies and the scientific and technical community concerned with the field of aeronautical engineering. The first issue of this bibliography was published in September 1970 and the first supplement in January 1971. Since that time, monthly supplements have been issued.

This supplement to *Aeronautical Engineering -- A Continuing Bibliography* (NASA SP-7037) lists 326 reports, journal articles, and other documents originally announced in October 1978 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*.

The coverage includes documents on the engineering and theoretical aspects of design, construction, evaluation, testing, operation, and performance of aircraft (including aircraft engines) and associated components, equipment, and systems. It also includes research and development in aerodynamics, aeronautics, and ground support equipment for aeronautical vehicles.

Each entry in the bibliography consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged in two major sections, *IAA Entries* and *STAR Entries*, in that order. The citations, and abstracts when available, are reproduced exactly as they appeared originally in *IAA* and *STAR*, including the original accession numbers from the respective announcement journals. This procedure, which saves time and money, accounts for the slight variation in citation appearances.

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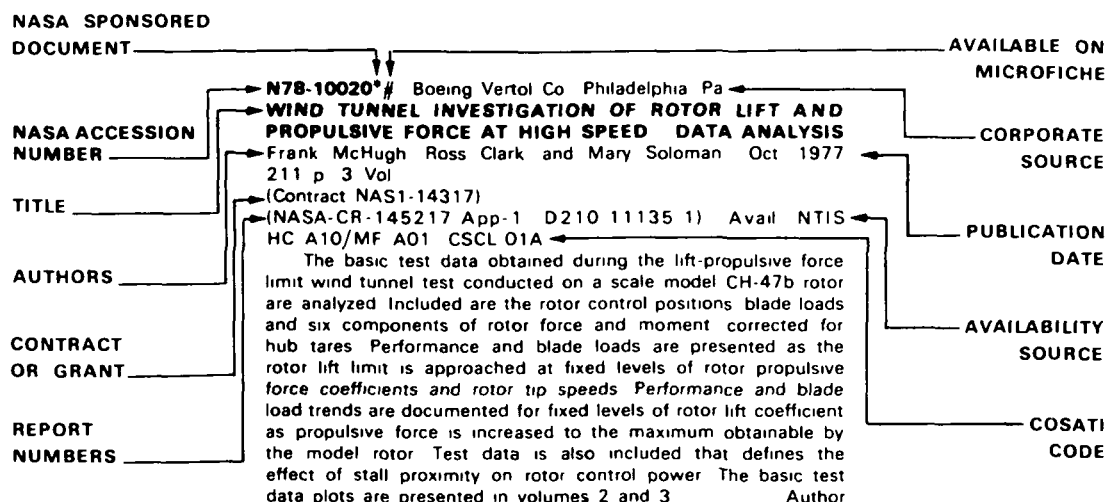
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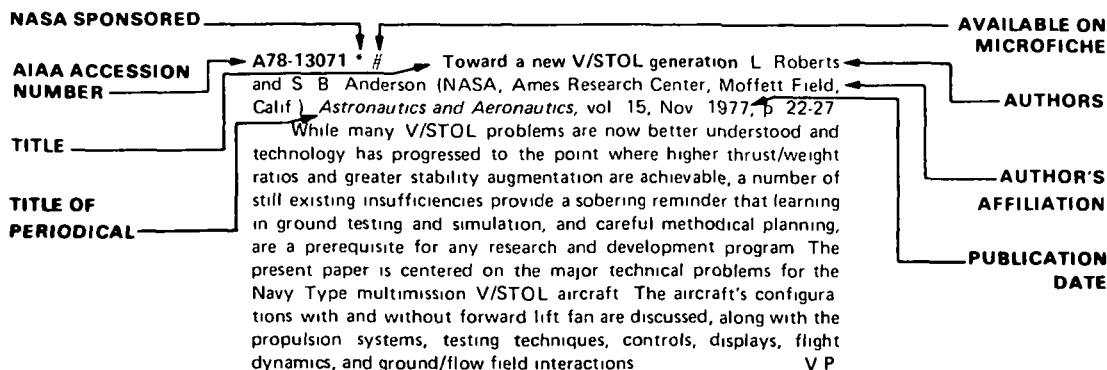
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AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 102)

NOVEMBER 1978

IAA ENTRIES

A78-43358 * # CTOL concepts and technology development D W Conner (NASA Langley Research Center, Systems Analysis Branch, Hampton, Va.) *Astronautics and Aeronautics*, vol 16, July-Aug 1978, p 29-37 11 refs

Various developments in the Aircraft Energy Efficiency (ACEE) program are discussed. Terminal-area operations are considered with emphasis on the Terminal Configured Vehicle program. Consideration is also given to aircraft systems studies and economics (including noise reduction programs), coal derived fuels for aviation systems (including LH2 fueled aircraft), and transport-aircraft concepts (including laminar flow control) B J

A78-43359 * # Airframes and aerodynamics R W Leonard (NASA, Langley Research Center, Hampton, Va.) *Astronautics and Aeronautics*, vol 16, July-Aug 1978, p 38-46

The first part of the paper discusses the Energy Efficient Transport program of the Aircraft Energy Efficiency (ACEE) program, giving attention to the development of active aerodynamics and active controls. The second part of the paper deals with two other portions of the ACEE program: Composite Primary Structures and Laminar Flow Control B J

A78-43360 * # Propulsion D L Nored (NASA, Lewis Research Center, Energy Conservative Engines Office, Cleveland, Ohio) *Astronautics and Aeronautics*, vol 16, July-Aug 1978, p 47-54, 119 14 refs

NASA aims at developing propulsion technology to reduce the fuel consumption of present engines by 5%, that of new engines of the late 1980s by at least 12%, and that of an advanced early 1990s turboprop by an additional 15%. This paper reviews three separate NASA programs which take up these aims. They are, respectively, Engine Component Improvement, Energy Efficient Engine, and Advanced Turboprops B J

A78-43415 * Jet fuels from synthetic crudes A C Antoine (NASA, Lewis Research Center, Cleveland, Ohio) and J P Gallagher (Atlantic Richfield Co., Harvey, Ill.) In *Coal processing technology* Volume 3 New York, American Institute of Chemical Engineers, 1977, p 107-114. Contract No. NAS3-19747

An investigation was conducted to determine the technical problems in the conversion of a significant portion of a barrel of either a shale oil or a coal synthetic crude oil into a suitable aviation turbine fuel. Three syncrudes were used, one from shale and two from coal, chosen as representative of typical crudes from future commercial production. The material was used to produce jet fuels of varying specifications by distillation, hydrotreating, and hydrocracking. Attention is given to process requirements, hydrotreating

process conditions, the methods used to analyze the final products, the conditions for shale oil processing, and the coal liquid processing conditions. The results of the investigation show that jet fuels of defined specifications can be made from oil shale and coal syncrudes using readily available commercial processes G R

A78-43416 Gas turbine engine fuel from synthetic crude F S Eisen and J D Tice (Suntech, Inc., Marcus Hook, Pa.) In *Coal processing technology* Volume 3 New York, American Institute of Chemical Engineers, 1977, p 115-121 7 refs

In an effort to expand the domestic supply base for liquid fuel, a program was initiated to evaluate the suitability of synthetic fuels (from coal, oil shale, and tar sands) for DOD needs. In this connection a contract was awarded to an American company to produce jet fuel from coal-derived synthetic crude oil. The objective was to provide JP-5 type jet fuel samples for testing. In the first phase of the project four 10-gal lots of jet fuel were prepared from coal syncrude. During the second phase 250 gal were produced of one of the fuels. The investigation shows that gas turbine engine fuels having 2.25 vol % aromatics, which meet most current JP-5 specifications, can be produced from the coal syncrudes tested. Severe hydrogenation conditions are required to reduce the aromatic content of the coal syncrude kerosene fraction to 20-25 vol % in one stage. Meeting the current JP-5 smoke point specification will be difficult for coal-derived fuels with aromatics greater than 20 vol % or so G R

A78-43417 Evaluation of coal-derived JP-5 fuels C J Nowack, J Solash, and R J Delfosse (U.S. Naval Air Propulsion Test Center, Trenton, N.J.) In *Coal processing technology* Volume 3 New York, American Institute of Chemical Engineers, 1977, p 122-126 5 refs

On the basis of an evaluation of the data obtained in the pilot plant experiment of an American company, it is concluded that it will be difficult to convert coal syncrudes from the Char Oil Energy Development process into a jet fuel having all the properties of the present MIL-T-5624K specification for grade JP-5 fuel. Those properties which will not be acceptable for a wide boiling range fuel, having an end point of 575 F, are specific gravity, viscosity, and smoke point on a 25% aromatic level. Development work on refining coal syncrudes should be conducted to improve process variables. This work should also include the development of catalysts that are resistant to those compounds in coal syncrudes which are responsible for deactivation. Both high and low aromatic fuels derived from Utah and Western Kentucky coals had acceptable storage and thermal oxidation stability G R

A78-43501 # Engine/airframe matching considerations for subsonic V/STOL aircraft A P Adamson, J A Lander, and D C Genever-Watling (General Electric Co., Cincinnati, Ohio) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-922* 10 p

V/STOL aircraft require up to four times the amount of propulsion equipment required in non-V/STOL aircraft of similar capability. Navy V/STOL Type A applications are discussed in terms of engine cycle selection, system configuration, control force generation, and interconnect and transmission systems. Attention is given to engines set at very low cruise power, and to the optimization of fan and turbine pressure and flow parameters for this configuration. Also considered are inlet operating temperature, fan airflow, and fuel weight. Thrust vectoring is discussed with reference to variable pitch engines. D M W

A78-43502 # The impact of current V/STOL flying quality control requirements on the propulsion system S J Craig, R K Lindbeck, and A W Shaw (Vought Corp., Dallas, Tex.) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-924* 8 p 5 refs

V/STOL propulsion system design is strongly affected by vehicle control requirements. Since vehicle control is a fundamental contributor to flying qualities, MIL F-83300 is used as a standard. This paper treats the propulsion system as an effector in the flight control system, i.e., the source for forces and moments applied to the airplane for trim, control and stability. An analogy is drawn to an actuator aerodynamic surface to develop propulsion system bandwidth and response characteristics. Partitioning of requirements according to frequency regimes facilitates defining the flight control system-propulsion system interface and modeling of the propulsion system for flight control definition. The distinction between height control (thrust to weight) and attitude control (thrust modulation) is shown to have a significant influence on airplane and propulsion system sizing. The understanding that one effector, thrust modulation, supplies more than one control point also strongly influences propulsion system sizing and relative core engine size. Asymmetric trim arising from engine malfunction requires special logic in the control system as well as knowledge of engine health. (Author)

A78-43503 # Advanced engine-inlet matching for a V/STOL 'B' fighter R H Tindell (Grumman Aerospace Corp., Bethpage, N Y) and J Flynn (U S Naval Air Propulsion Test Center, Trenton, N J) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-925* 13 p

The variable-cycle engine (VCE) is a promising concept for improving advanced aircraft-mission compatibility. When evaluating VCEs, it is important to ensure efficient inlet-engine airflow matching, as a mismatch could mask the resulting trends and lead to wrong conclusions. Moreover, some VCEs may have corrected airflow characteristics so dissimilar from conventional engines that special inlet innovations are necessary. This paper describes the results of a study aimed at evaluating the effects of 4 VCEs and a baseline conventional engine on the takeoff gross weight of a Type B V/STOL fighter, designed for a deck-launched-intercept mission. A transonic wind tunnel program provides a data base for the performance and operating characteristics of a high flow inlet design, for meeting anticipated airflow matching needs of some VCEs. The benefits of inlet engine matching with optimized inlet capture areas for both conventional and high-flow inlets are discussed and summarized. The major conclusion of this study is that the best VCE, with a conventional inlet, provided a 2850 lb (8.9%) lower take-off gross weight (TOGW) than a current technology engine. (Author)

A78-43504 * # Design approaches to more energy efficient engines N T Saunders, R S Colladay, and L E Macioce (NASA, Lewis Research Center, Cleveland, Ohio) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-931* 10 p 5 refs

In 1976 NASA initiated the Aircraft Energy Efficiency (ACEE) Program to assist in the development of technology for more fuel-efficient aircraft for commercial airline use. The Energy Efficient Engine (EEE) Project of the ACEE program is intended to lay the advanced-technology foundation for a new generation of turbofan engines. This project, planned as a seven-year cooperative government-industry effort, is aimed at developing and demonstrating advanced component and systems technologies for engines that could be introduced into airline service by the late 1980s or early 1990s. In addition to fuel savings, new engines must offer potential for being economically attractive to the airline users and environmentally acceptable. A description is presented of conceptual energy-efficient engine designs which offer potential for achieving all of the goals established for the EEE Project. G R

A78-43505 * # General aviation internal combustion engine research programs at NASA-Lewis Research Center E A Willis (NASA, Lewis Research Center, Cleveland, Ohio) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-932* 15 p 17 refs

An update is presented of non turbine general aviation engine programs underway at the NASA-Lewis Research Center in Cleveland, Ohio. The program encompasses conventional, lightweight diesel and rotary engines. Its three major thrusts are (a) reduced SFC's, (b) improved fuels tolerance, and (c) reducing emissions. Current and planned future programs in such areas as lean operation, improved fuel management, advanced cooling techniques and advanced engine concepts, are described. These are expected to lay the technology base, by the mid to late 1980's, for engines whose life cycle fuel costs are 30 to 50% lower than today's conventional engines. (Author)

A78-43512 # Application of modular modeling to ramjet performance prediction P T Harsha and R B Edelman (Science Applications, Inc., Woodland Hills, Calif.) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-944* 12 p 25 refs. Contracts No F49620-77-C-0044, No F33615-77-C-2062

Modular modeling represents an engineering approach to the computation of complex flowfields wherein the discrete elements of the flowfield are characterized by specific models and these models are coupled together to represent the overall combustor flowfield. Although the specific models can be highly simplified representation of flowfield elements, the greatest advantage of modular modeling is achieved through the use of detailed characterization of each element. Through a comparison of semi-empirical, zero-dimensional, one-dimensional, and two-dimensional modular modeling approaches, and of the results obtained using a detailed two-dimensional modular model to predict liquid fuel injection processes and the details of sudden expansion and conventional ramjet flowfields, it is shown that the detailed modular approach offers significant advantages relative to unified models of combustor flowfields. Further, the physical insights gained through the use of modular models are critical to the development of more comprehensive, unified Navier Stokes models. (Author)

A78-43514 # Numerical simulation of combustor flow fields - The development and application of a primitive variable design capability A S Novick, G A Miles (General Motors Corp., Detroit Diesel Allison Div., Indianapolis, Ind.), and D G Lilley (Concordia University, Montreal, Canada) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-949* 12 p 23 refs

In order to complement associated experimental studies, the development of a theoretical approach to the evaluation of gas turbine combustors is extremely attractive. For this purpose a computer program is needed which starts from hypotheses about the

fundamental processes and predicts the distributions of velocity, concentrations, and temperature. A new primitive pressure-velocity variable, finite difference computer code has been developed to allow the computation of inert and reacting turbulent swirling flows in an axisymmetric combustor. The method and program involve a staggered grid system for axial and radial velocities, and a line relaxation technique for efficient solution of the equations. Turbulence simulation is by way of a two-equation k -epsilon model, combustion via a simple one-step chemical reaction model based on Arrhenius and eddy-breakup concepts for diffusion or premixed situations. Computational results show the interesting effects of combustor design parameters (such as degree of swirl, existence of a recirculation zone amplifier, i.e., 'trip', and effect of laterally-induced secondary air supply) on subsequent flowfield development and combustor performance. Available experimental data provide confirmatory comparisons. (Author)

A78-43519 # Design and experimental studies of a type 'A' V/STOL inlet. H. C. Potonides, R. A. Cea, and T. F. Nelson (Grumman Aerospace Corp., Bethpage, N.Y.) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-956* 9 p.

Design and experimental studies have been conducted to evolve a high performance, high angle of attack capability inlet for subsonic V/STOL applications. Design criteria were selected to satisfy both low and high flight speeds. It is shown that the selected control system has a significant effect on the inlet requirements. Based on these studies, several fixed inlets were designed, fabricated and tested in the Grumman Low Speed tunnel. Inlet performance and separation bounds were determined. Discussed also is a joint test program with NASA Lewis to investigate both active and passive means of forestalling inlet separation in order to shorten and slenderize the nacelle. (Author)

A78-43520 * # VSTOL tilt nacelle aerodynamics and its relation to fan blade stresses. R. J. Shaw, R. C. Williams (NASA, Lewis Research Center, Cleveland, Ohio), and J. L. Koncsek (Boeing Aerospace Co., Boeing Military Airplane Development, Seattle, Wash.) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-958* 11 p. 9 refs.

A scale model of a VSTOL tilt nacelle with a 0.508 m single stage fan was tested in the NASA Lewis 9x15 Low Speed Wind Tunnel to ascertain inlet aerodynamic and fan aeromechanical performance over the low speed flight envelope. Fan blade stress maxima occurred at discrete rotational speeds corresponding to integral engine order vibrations of the first flatwise bending mode. Increased fan blade stress levels coincided with internal boundary layer separation occurring but became severe only when the separation location had progressed to the entry lip region of the inlet. The inlet/fan system could operate within the low speed flight envelope without incurring fan blade stress limits although boundary layer separation did occur for certain operating conditions. (Author)

A78-43521 * # Effects of inlet airframe integration on the inlet of an upper surface blowing four-engine STOL aircraft. M. D. Shovlin (NASA, Ames Research Center, Moffett Field, Calif.) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-959* 9 p. 7 refs.

Inlet and nacelle static pressures were measured on a 0.55 scale model of the Quiet Short Haul Research Airplane (QSRA) in the Ames Research Center's 40 by 80 Foot Wind Tunnel. This model is powered by four JT 15D engines located above the wing with closely spaced adjacent inlets. A fifth JT 15D engine in the fuselage provides boundary-layer control air. Each inlet was instrumented with four to eight rows of axial pressure taps located between X/R approximately plus or minus 1. The tests simulated a broad range of aircraft

operating conditions including engine-out with lift coefficients from 0.8 to 10.0. Results indicate that the inlets perform well under most operating conditions with little interaction between inlets when the aircraft is moving. Potential problem areas identified are high sideslip angle during approach and an interaction effect between adjacent inlets with high mass flows in static conditions. (Author)

A78-43522 # A subsonic ramjet engine for expendable drones. G. J. Brown, G. L. Harris, and G. R. Seemann (Developmental Sciences, Inc., City of Industry, Calif.) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-962* 4 p.

A low-cost ramjet engine of unusual configuration has been developed to propel an expendable subsonic drone in the speed range from $M=0.6$ to $M=0.9$ at altitudes from MSL to 20,000 ft. This engine, called the resonating ramjet (RRJ), is configured with a side inlet to permit compact installation of the propulsion unit within the vehicle and the use of a solid rocket booster motor inside the engine itself. For ground launch, the rocket motor accelerates the drone to a Mach number of 0.7 and is then expelled by ram pressure, allowing the ramjet to light and sustain cruising flight. Development and performance testing included direct connect, free jet, and in flight tests. These techniques are briefly reviewed. Measured performance is presented and compared with 'ideal ramjet' performance. (Author)

A78-43523 # Expendable design concept. D. C. Hall (USAF, Aero Propulsion Laboratory, Wright Patterson AFB, Ohio) and H. F. Due, Jr. (Teledyne CAE, Toledo, Ohio) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-964* 5 p.

A gas generator used as the core of a jet fuel starter is described to illustrate the expendable design concept, whereby a piece of hardware is discarded at the end of its useful life. Comparisons are drawn between this concept and the more traditional approach of overhaul and repair. In the area of jet fuel starter technology, the expendable design concept permits significant cost reductions while improving performance. D. M. W.

A78-43525 * # Estimating maximum instantaneous distortion from inlet total pressure rms measurements. H. C. Melick, Jr. A. H. Ybarra (Vought Corp., Dallas, Tex.), and D. P. Bencze (NASA, Ames Research Center, Moffett Field, Calif.) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-970* 15 p. 12 refs. Contracts No. NAS2 6901, No. NAS2 8878.

In the present paper, a new mathematical model of inlet turbulence is developed by application of basic fluid dynamics and statistical concepts. The model provides an understanding of the turbulent inlet flow as well as a means of describing the flow in quantitative terms. Specifically, the maximum instantaneous distortion produced by inlet unsteady flow can be estimated by the simple measurement of rms data. Practical application of these techniques leads to a data/acquisition/reduction system that is at least one, and maybe two, orders of magnitude less expensive than conventional methods. Each data point can be reduced in terms of the mean strength of the turbulent vortices. By storing these two parameters (that are representative of the unsteady flow with the steady state information), the maximal instantaneous distortion can be reconstructed for other distortion factors at any time subsequent to the test. V. P.

A78-43540 * # Comparison of nozzle and afterbody surface pressures from wind tunnel and flight test of the YF-17 aircraft. E. J. Lucas (ARO, Inc., Arnold Air Force Station, Tenn.), A. E. Fanning (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio), and L. I. Steers (NASA, Flight Research Center, Edwards AFB, Calif.) *American Institute of Aeronautics and Astronautics and*

Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-992 12 p 6 refs

Results are reported from the initial phase of an effort to provide an adequate technical capability to accurately predict the full scale, flight vehicle, nozzle-afterbody performance of future aircraft based on partial scale, wind tunnel testing. The primary emphasis of this initial effort is to assess the current capability and identify the cause of limitations on this capability. A direct comparison of surface pressure data is made between the results from an 0.1-scale model wind tunnel investigation and a full scale flight test program to evaluate the current subscale testing techniques. These data were acquired at Mach numbers 0.6, 0.8, 0.9, 1.2, and 1.5 on four nozzle configurations at various vehicle pitch attitudes. Support system interference increments were also documented during the wind tunnel investigation. In general, the results presented indicate a good agreement in trend and level of the surface pressures when corrective increments are applied for known effects and surface differences between the two articles under investigation. (Author)

A78-43541 # **Computation of a supersonic flow past an axisymmetric nozzle boattail with jet exhaust** A. G. Mikhail (Dayton, University, Dayton, Ohio), W. L. Hankey, and J. S. Shang (USAF, Flight Dynamics Laboratory, Wright Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-993* 12 p 24 refs. Contract No. F33615-76-C-3145

Numerical solutions for supersonic flow at Mach number 1.5 past the AGARD 10 deg-axisymmetric nozzle boattail with jet exhaust are obtained using the Navier-Stokes equations. The major objective is to show that such a complex flow can be computed successfully, rather than emphasizing accuracy or computational efficiency. The explicit McCormack's second-order accurate scheme is used together with surface oriented coordinates obtained through numerical mapping procedure. Several engineering judgments had to be made regarding the flow conditions, shape and extension of the region of computation, the coordinate system chosen, mesh point distribution and turbulence models used. Five cases were computed showing the effects of boattail geometry, jet exhaust temperature, boattail wall temperature and the two dimensional vs axisymmetry differences. Contours of flow variables such as static temperature for infrared signature detection, and the surface pressure distributions are provided. Comparison with the limited available experimental results is made, with the possible interpretation for the deviation being discussed. Several recommendations for improving accuracy are suggested. (Author)

A78-43542 * # **An improved analytical model of the separated region on nozzle boattails** W. M. Presz, Jr., J. D. Buteau (United Technologies Corp., Pratt and Whitney Aircraft Group, East Hartford, Conn.), R. W. King (United Technologies Corp., Chemical Systems Div., Sunnyvale, Calif.), and L. E. Putnam (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev. July 25-27, 1978, AIAA Paper 78-995* 8 p 12 refs. Contract No. NAS114462

A viscous flow calculation is formulated for modeling the effects of separated, reverse flow regions on nozzle afterbody pressures and drags at subsonic Mach numbers. A discriminating streamline approach is used. Effects of skin friction, axial pressure gradient, and nozzle jet entrainment on the separated discriminating streamline shape are included. The viscous flow calculation is coupled to a potential flow calculation. The combined analysis is found to accurately predict both the magnitude of the measured afterbody pressures and drag, and also their variation with Reynolds number, Mach number and afterbody shape. (Author)

A78-43543 # **Low frequency augmentor instability study** P. L. Russell, G. Brant, R. C. Ernst (United Technologies Corp., Pratt and Whitney Aircraft Group, West Palm Beach, Fla.), and F. N. Underwood, Jr. (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-996* 11 p 5 refs

With the advent of the mixed-flow afterburner in turbofan engines, a type of low frequency instability known as rumble became a serious problem. Rumble occurs mainly at high fuel-air ratios and at flight Mach numbers and altitudes where low duct inlet air temperatures and pressures exist. To aid the development engineer in designing rumble-free afterburners an analytical model has been formed. Rumble mechanisms investigated early in this study involved system airflow dynamics, combustion efficiency oscillations, fuel vaporization and recirculation wake energy. The model was then refined and extended to include the mixed flow experienced in a turbofan augmentor. Predictions were made for the effects of altitude, fan stream fuel-air ratio, fan stream temperature, core stream fuel-air ratio, and fan duct pressure loss. The efficiency falloff in the fan stream at high fuel-air ratio causes rumble. This will be evaluated with engine altitude tests at NASA Lewis Research Center with several augmentor configurations. These tests include heat addition to the fan stream, fuel-air distribution changes and spraybar to flameholder length variation. The basic formulation of the model, the mixed flow augmentor model, predictions, and the experimental programs are discussed. (Author)

A78-43544 * # **Design and preliminary results of a semi-transpiration cooled /Lamilloy/ liner for a high-pressure high-temperature combustor** J. D. Wear, A. M. Trout, J. M. Smith, and R. E. Jones (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-997* 8 p 5 refs

A Lamilloy combustor liner has been designed, fabricated and tested in a combustor at pressures up to 8 atmospheres. The liner was fabricated of a three layer Lamilloy structure and designed to replace a conventional step-louver liner. The liner will be used in a combustor that provides hot gases to a turbine cooling test facility at pressures up to 40 atmospheres. The Lamilloy liner was tested extensively at lower pressures and demonstrated lower metal temperatures than the conventional liner, while at the same time requiring about 40 percent less cooling air flow. Tests conducted at combustor exit temperatures in excess of 2200 K have not indicated any cooling or durability problems with the Lamilloy liner. (Author)

A78-43545 # **An empirical/analytical design methodology for gas turbine combustors** H. C. Mongia (Air Research Manufacturing Company of Arizona, Phoenix, Ariz.) and K. F. Smith (U. S. Army, Applied Technology Laboratory, Fort Eustis, Va.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-998* 15 p 18 refs

This paper presents a description of a combustor design procedure based upon both well-developed empirical correlations and analytical combustor flow, and kinetic models to predict combustor performance parameters. It includes a brief description of the application of the empirical/analytical combustor design technique. The paper summarizes the development testing of two small, full scale, advanced, combustion systems of reverse flow annular configuration, but significantly different from each other in internal flow distribution. The application of the advanced design technique resulted in significant reductions of combustor development time and costs. (Author)

A78-43546 * # **Combustor concepts for aircraft gas turbine low-power emissions reduction** E J Mularz (NASA, Lewis Research Center, U S Army, Air Mobility Research and Development Laboratory, Cleveland, Ohio), C C Gleason, and W J Dodds (NASA, Lewis Research Center, Cleveland, General Electric Co., Evendale, Ohio) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-999* 11 p 6 refs Contract No NAS3-20580

Three combustor concepts have been designed and tested to demonstrate significant reductions in aircraft engine idle pollutant emissions. Each concept used a different approach for pollutant reductions: the Hot Wall Combustor employs a thermal barrier coating and impingement cooled liners, the Recuperative Cooling Combustor preheats the air before entering the combustion chamber, and the Catalytic Converter Combustor is composed of a conventional primary zone followed by a catalytic bed for pollutant cleanup. The designs are discussed in detail and test results are presented for a range of aircraft engine idle conditions. The results indicate that ultra-low levels of unburned hydrocarbons and carbon monoxide emissions can be achieved with this technology. (Author)

A78-43547 # **Combustion performance of gas turbine combustors burning alternative fuels** D R Ballal and A H Lefebvre (Purdue University, West Lafayette, Ind.) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-1000* 8 p 5 refs

Equations for predicting and correlating the combustion efficiencies of gas turbine combustors are derived for conditions where the heat release is limited either by chemical reaction, mixing or evaporation, or by a combination of reaction and evaporation. Methods for calculating the critical mean drop size, D_{crit} , above which evaporation becomes the rate-controlling step are presented. It is shown that D_{crit} increases with increase in combustion volume, combustion pressure, liner pressure drop and fuel volatility, and diminishes with increase in gas velocity. It is also shown that the ignition energy requirements of liquid hydrocarbon fuels are influenced mainly by their viscosity and volatility, which together govern the rate of fuel evaporation in the ignition zone. (Author)

A78-43555 # **The influence of V/STOL vehicle configuration variables on vectored jet induced flow fields in ground effect** D R Kotansky (McDonnell Aircraft Co., St. Louis, Mo.) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-1021* 12 p 9 refs Contract No N62269-76-C 0086

The sensitivity of V/STOL lift system jet induced forces and moments in ground effect to aircraft configuration variables is demonstrated. The configuration variables considered are (1) lift system arrangement, (2) basic airframe geometry, (3) nozzle exit geometry, and (4) passive lift improvement devices. The sensitivity of the induced aerodynamic forces and moments to these geometric variables is demonstrated by describing the fluid mechanics of the responsible flowfield phenomena, and then showing the sensitivity of these flowfields (and their induced effects) to the pertinent airframe and flow geometry in ground effect. A brief synopsis of relevant prediction techniques is included to aid the vehicle configuration analyst. (Author)

A78-43556 * # **A review of thrust-vectoring schemes for fighter applications** B L Berrier and R J Re (NASA, Langley Research Center, High Speed Aerodynamics Div., Hampton, Va.) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-1023* 11 p 26 refs

This paper presents a review of thrust vectoring schemes for advanced fighter applications. Results are presented from wind tunnel and system integration studies on thrust vectoring nozzle concepts. Vectoring data are presented from wind tunnel tests of

axisymmetric C-D (convergent divergent) and nonaxisymmetric wedge, C-D, single ramp and USB (upper-surface blowing) nozzle concepts. Results from recent airframe/nozzle integration studies on the impact of thrust vectoring on weight, cooling and performance characteristics are discussed. This review indicates that the aircraft designer has, at his disposal, a wide range of thrust vectoring schemes which offer potential for added or improved aircraft capability.

(Author)

A78-43566 # **Flame stabilization in simplified prevaporizing, partially vaporizing and conventional gas turbine combustors** S L Plee and A M Mellor (Purdue University, West Lafayette, Ind.) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-1038* 11 p 47 refs USAF Army-sponsored research

Lean blowoff equivalence ratios are presented using conventional correlating parameters for two different axisymmetric flameholder configurations. These simplified geometries model the same fundamental combustion processes of conventional and advanced prevaporizing/premixing gas turbine combustors while eliminating some of the complexity of practical hardware. Combustor pressure, inlet temperature, air velocity, geometry, injector size and fuel type are varied over ranges typical of gas turbine combustor operation. Results indicate that the flame is predominantly mixing controlled, however, heterogeneous effects associated with fuel variations show that increasing the initial droplet size narrows the lean limit while increasing fuel penetration actually enhances flame stabilization.

(Author)

A78-43567 * # **The effect of cycle variables on the emissions and performance of lean premixed gas turbine primary zone combustor** G Roffe and K S Venkataramani (General Applied Science Laboratories, Inc., Westbury, N.Y.) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-1039* 9 p NASA-supported research

Experiments were conducted in which a stream of premixed propane and air was burned under conditions representative of gas turbine operation. Emissions of NO_x, CO, and unburned hydrocarbons were measured over a range of combustor inlet temperature (600-1000 K), pressure (5-30 atm), and residence time (1-3 msec) at equivalence ratios from 0.7 down to the lean stability limit. At inlet temperatures of 800 and 1000 K, NO_x emissions displayed little sensitivity to pressure. At an inlet temperature of 600 K, observed NO_x levels dropped markedly with decreasing pressure for pressures below 20 atm. NO_x levels were proportional to combustor residence time, and formation rate was principally a function of adiabatic flame temperature. For adiabatic flame temperatures of 2050 K and higher, CO reached chemical equilibrium within 2 msec. Unburned hydrocarbon species dropped to a negligible level within 2 msec regardless of inlet temperature, pressure, or equivalence ratio. For a combustor residence time of 2.5 msec, combustion inefficiency became less than 0.01% at an adiabatic flame temperature of 2050 K. The maximum combustion inefficiency observed was of the order of 1% and corresponded to conditions near the lean stability limit.

(Author)

A78-43568 * # **Design and verification of a turbofan swirl augmentor** W J Egan, Jr. and J H Shadowen (United Technologies Corp., Pratt and Whitney Aircraft Group, West Palm Beach, Fla.) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-1040* 8 p 12 refs Contract No NAS3-20588

The paper discusses the details of the design and verification testing of a full-scale turbofan 'swirl' augmentor at sea level and altitude. No flameholders are required in the swirl augmentor since the radial motion of the hot pilot gases and subsequent combustion products provides a continuous ignition front across the stream.

Results of rig testing of this full-scale swirl augmentor on an F100 engine, which are very encouraging, and future development plans are presented. The results validate the application of the centrifugal-force swirling flow concept to a turbofan augmentor. S D

A78-43574 # Integration of a variable cycle engine concept in a supersonic cruise aircraft. R H Brown (General Electric Co., Aircraft Engine Group, Evendale, Ohio). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-1049* 7 p

General Electric Company conducted NASA funded studies to evaluate many different supersonic cruise propulsion concepts and cycle studies for potential application in an advanced supersonic cruise aircraft. Engine concepts were refined to match the in-house study of aircraft characteristics, and data were provided to the aircraft companies for evaluation. Over a two year period, close integration with the aircraft companies improved matching of engine and airplane designs and resulted in a major improvement in aircraft range over that with the original engine offerings. This paper reviews the integration effort and shows the system improvements that did result for one variable cycle engine concept. (Author)

A78-43575 # Integrated control systems for advanced supersonic engines. R A Howlett and E C Beattie (United Technologies Corp., Pratt and Whitney Aircraft Group, East Hartford, Conn.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-1050* 11 p 10 refs

The Variable Stream Control Engine (VSCE) being studied for future supersonic transport aircraft shows potential for significant improvements relative to first generation supersonic turbojet engines. This engine concept has two separate flow streams - each with independent burner and nozzle systems. By unique control of the exhaust temperatures and velocities in these two streams, significant performance improvements and reductions in jet noise may be obtained. Because the VSCE concept makes extensive use of variable components, and because of the requirements to integrate the inlet, engine, and nozzle control systems together as well as with the aircraft controls, an advanced digital electronic control system is required. This advanced control system will help provide the operational flexibility for meeting environmental regulations, and will improve the performance, stability, and safety characteristics of this unique engine. The integrated control system is one of the critical technology areas that requires research and development to realize the full potential of the VSCE. (Author)

A78-43576 # Engine options for supersonic cruise aircraft. P H Calder and P C Gupta (Rolls-Royce, Ltd., Aero Div., Bristol, England). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-1054* 18 p 11 refs

Concorde supersonic passenger services from Paris and London to South America and the Middle East began nearly two and a half years ago and were extended to North America two years ago. At the end of April 1978 some 54,000 hours of engine service experience had been accumulated in the course of 4500 flights. It is pointed out that Concorde and its powerplant have met their payload range performance objectives. The Concorde represents a flying example of the integration of propulsion system and airframe. Attention is given to considerations related to the choice of the engine for Concorde, advancements in technology leading to an improvement of performance and the reduction of noise, engine studies, an integrated aircraft/engine study, a study of duct burning, noise tests on coannular jets, questions of mechanical silencing, installation considerations, the choice of the cruise Mach number, and the advantages of variable cycle engines. G R

A78-43587 * # Low speed aerodynamic characteristics of a vectored-engine-over-wing configuration. L D Leavitt (NASA, Langley Research Center, High Speed Aerodynamics Div., Hampton, Va.), P D Whitten (General Dynamics Corp., Fort Worth, Tex.), and S C Stumpf (USAF, Flight Dynamics Laboratory, Wright Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-1081* 11 p 18 refs

An investigation has been conducted in the Langley V/STOL tunnel to determine the low speed aerodynamic characteristics of a close coupled canard wing configuration using spanwise blowing and a vectored-engine-over-wing powered lift concept. The effects of spanwise blowing in conjunction with thrust vectoring are discussed. These effects were studied at $M = 0.19$ for a range of model angle of attack and engine nozzle pressure ratio. The results indicate combined use of spanwise blowing and thrust vectoring can provide significant performance improvements throughout the angle of attack range tested. (Author)

A78-43588 # An investigation of the induced aerodynamic effects of a vectored non-axisymmetric exhaust nozzle. D L Bowers (USAF, Flight Dynamics Laboratory, Wright Patterson AFB, Ohio) and F Buchan (USAF, Foreign Technology Div., Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-1082* 9 p 8 refs

Non-axisymmetric exhaust nozzles exiting at or near the trailing edge of a lifting surface offer advanced aircraft configurations improved performance by induced aerodynamic effects. An experimental investigation of these induced effects was conducted at Mach numbers from 0.3 to 0.9 on a half-span wing body configuration with a vectoring (0, 15, 30 degree) non axisymmetric exhaust nozzle incorporated into the wing trailing edge. Results indicate that at all Mach numbers, the thrust-removed lift, drag, and pitching moment coefficients for the wing body increased with increasing nozzle vectoring. Using the untrimmed data, an optimum drag polar can be formed which uses all three vector angles. As the nozzle pressure ratio increased, the induced effects on the wing aerodynamics tend to increase proportionally. (Author)

A78-43589 * # The effect of over-the-wing nacelles on wing-body aerodynamics. D E Reubush (NASA, Langley Research Center, High-Speed Aerodynamics Div., Hampton, Va.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-1083* 12 p 13 refs

An investigation was conducted in the Langley 16-foot transonic tunnel to further study benefits in climb and cruise performance due to blowing the jet over the wing for a transport type wing-body configuration. In this investigation a wing-body model/powered-nacelle test rig combination was tested at Mach numbers of 0.5 and 0.8 at angles of attack from -2 to 4 deg and jet total-pressure ratios from jet off to 3 or 4 (depending on Mach number) for a variety of nacelle locations relative to the wing. Results from this investigation show that positioning of the nacelles can have very large effects on the wing-body drag (nacelles were nonmetric). Some positions yielded much higher drag than the baseline wing body while others yielded drag which was somewhat lower than the baseline. (Author)

A78-43590 # Using accelerated mission testing as a tool within the F100 engine component improvement program. J Sammons (United Technologies Corp., Pratt and Whitney Aircraft Group, West Palm Beach, Fla.) and J Ogg (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-1085* 4 p

The Accelerated Mission Test (AMT) built around data from recorders on each F100 engine in the F 15 has become a focal point of the Component Improvement Program (CIP). AMT engines have

successfully detected fatigue and erosion problems ahead of the fleet in time to set limits and substantiate redesigns. Along with the Lead the Force Pacer Century program these engines have allowed the progressive advance of maximum operating hours to 1000 hr on the major F100 modules. The AMT engines are also used to substantiate engineering changes, San Antonio ALC repairs, and establish manual limits for the field and depot. Provisioning forecasts are made from the analytical teardown inspections of both the AMT and Pacer Century engines. A projection of engine usage in the F 16 was made and 3000 equivalent hours of testing to this mission has been accomplished before the first F-16 aircraft becomes operational. (Author)

A78-43591 # Aeroelastic instability in F100 labyrinth air seals. D A Lewis, C E Platt, and E B Smith (United Technologies Corp., Pratt and Whitney Aircraft Group, West Palm Beach, Fla.) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-1087* 8 p. 12 refs.

Analysis of an aeroelastically unstable F100 labyrinth air seal has shown a stable design could be produced by tailoring the knife-edge lip clearance. An extensive engine experimental program confirmed that seals experienced high cycle fatigue (HCF) cracking resulting from seal instability. The primary driver of the instability was knife-edge clearance. Correlation has been demonstrated between analytically predicted instability and that observed during test engine operation. Experimental apparatus was developed to selectively augment or squelch the instability. These techniques improve definition of stability boundaries and provide a conservative means of substantiating stability margin with the revised configuration. (Author)

A78-43592 # T58 propulsion system duty cycle. S M Cote (U S Naval Material Command, Naval Air Development Center, Warminster, Pa.) and J L Byers (U S Naval Air Systems Command, Propulsion Systems Div., Washington, D C.) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-1088* 9 p. 9 refs.

Numerous durability problems have plagued Navy propulsion systems because the operational environment has been more severe than anticipated. In the past, the Navy has placed more emphasis on combat requirements in specifying design requirements rather than the peacetime environment. Future engine developments including the T700 turboshaft will be required to pass a Simulated Mission Endurance Test (SMET) prior to being qualified. Development of the SMET began with an intensive survey of flight profiles at various Naval Air Stations along with pilot interviews at both training and fleet squadrons. This survey resulted in seven representative missions for the LAMPS type helicopter. Flight testing provided continuous recordings of major engine parameters over the time history of each profile. Computer aided analysis of these data provide the history plots and a gas generator rotor speed matrix with calculated times at power setting. Results show a much more severe endurance test compared with MQT. SMET details are illustrated by the difference between proposed and actual mission power required. (Author)

A78-43593 # A research program for the experimental analysis of blade instability. D H Ellis, W J Rakowski (General Electric Co., Evendale, Ohio), and H R Bankhead (USAF, Aero Propulsion Laboratory, Wright Patterson AFB, Ohio.) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-1089* 7 p.

A research program and initial results from a unique, non rotating Annular Cascade vehicle utilized for experimental analysis of axial flow turbo machinery blade instability is described herein. The vehicle design was aimed at state-of the art investigation of negative incidence/choke instability, and positive incidence instability, in the

Mach number regime from 0.2 to 1.2. The ultimate objective of the program was to establish design criteria for use in the airfoil design process. This criteria is intended to define instability boundaries such that adequate flutter margins will be predictable in terms of blade structural and aerodynamic parameters. This four phase, 48 month program has completed its first two phases and results from the Phase II vehicle functional checkout and design verification testing are discussed herein. (Author)

A78-43635 Simple theory of spinning with particular reference to the HS Gnat trainer. E N Crabbe (British Aerospace Aircraft Group, Kingston-Brough Div., Dunsfold, Surrey, England) *Aeronautical Journal*, vol 82, May 1978, p. 223-228.

The reasons for the prohibition of spinning in the HS Gnat trainer are outlined in terms of the physical forces which affect flight. Attention is given to the balance of moments, e.g., aerodynamic pitching, yawing, and rolling moments, and roll, pitch, and yaw inertia. The effects of controls are discussed with reference to rudder, aileron, and tailplane action on various types of spin. *Modifications of aircraft design for the Gnat are reviewed, e.g., fuselage strakes and wing fence configurations designed to eliminate oscillatory and flat spin.* D M W

A78-43643 # Investigation of turbine stages with radial blades. (Issledovanie turbinnykh stupeney s radial'nymi lopatkami) V P Iakovlev and I I Mitushkin (Leningradskii Korablistroitel'nyi Institut, Leningrad, USSR) *Energetika*, vol 21, Apr 1978, p. 57-61. 7 refs. In Russian.

Results of the wind tunnel testing of a turbine stage with radial nozzle and rotor blades are presented, the investigation was conducted for two maximum profile thicknesses of nozzle blades. It is found that the use of radial blades in high-temperature gas turbines leads to an increase of turbine efficiency (to a reduction of losses in the cascade) and to improvements in the dynamic strength of rotor blades. B J

A78-43644 # Investigation of two-tier blade diffusers of centrifugal compressors. (Issledovanie dvukh'yarusnykh lopatochnykh diffuzorov tsentrobezhnogo kompressora) S A Anisimov, V A Sherstiukov, A I Apanasenko, I V Medvedev, and V V Rossel' (Leningradskii Politehnicheskii Institut, Leningrad, USSR) *Energetika*, vol 21, Apr 1978, p. 62-67. 9 refs. In Russian.

Centrifugal compressor stages with various kinds of two tier blade diffusers were tested in a wind tunnel and the data were analyzed on the basis of electromagnetic simulation of flow in the diffusers. The use of an optimal symmetrical two-tier diffuser cascade instead of a one tier cascade leads to an increase in the slope of the stage characteristics and extends the range of the operational modes of the stage. The shape of the initial-cascade profile and the short-blade profile exert a considerable influence on the operation of a two-tier diffuser. B J

A78-43690 Note on the spanwise quadrature in lifting-wing calculations. B Wagner and X Hafer (Darmstadt, Technische Hochschule, Darmstadt, West Germany) *Journal of Engineering Mathematics*, vol 12, July 1978, p. 245-250. 6 refs.

Spanwise integrations in lifting-line and lifting-surface theory are usually carried out with the aid of interpolation functions based on the theory of orthogonal polynomials. A description is presented of an improvement of the method reported by van de Vooren (1967). The improvement makes it possible to reduce the computer-time requirements for calculations involving a use of the considered method. Compared with the quadrature method presented by Multhopp (1938) the computation time in the case of the same number of stations per half span increases only by about 20 percent while all the advantages of van de Vooren's method are retained.

G R

A78-43762 Landing gear kinematics (Les cinématiques du train d'atterrissage) J Veaux (Messier-Hispano Bugatti, Montrouge, Hauts-de-Seine, France) *L'Aeronautique et l'Astronautique*, no 70, 1978, p 3-15 In French

The functions, operation, and kinematic principles of the main types of landing gears are discussed. A general procedure for designing a landing gear for a given airplane is described, where the main question is choosing the kinematic principle best adapted to the aircraft. The use of computer aided design in this process is discussed. PTH

A78-43800 # VASI-S - A visual landing aid (VASI-S - Wizualna pomoc do ladowania) A Mokrowiecki *Technika Lotnicza i Astronautyczna*, vol 33, June 1978, p 19-21 5 refs In Polish

The general characteristics of the Visual Approach Slope Indicator System (VASI-S) are described. The way the system works is described for both the basic system and the special 3-BAR VASI-S. Installation of the system is discussed. PTH

A78-43863 Boundary layer development on axial-flow turbomachinery blading R L Evans (British Columbia Energy Commission, Energy Conservation and Technology Div., Vancouver, Canada) In *Pumps Analysis, design and application* Volume 1 (A78-43862 19 37) Mountainside, N.J., Worthington Pump, Inc., 1978, p 1-15 9 refs

Both time mean velocity profiles and instantaneous ensemble-averaged profiles on the suction surface of a stator blade are measured and compared with boundary layer measurements on a cascade blade. The most striking difference in the time mean measurements is the very much larger rate of boundary layer growth on the stator blade as compared to the cascade blade. The boundary layer is found to be highly unsteady and transitional over much of the blade chord. At the 70% chord position, the boundary layer is fully turbulent during the whole cycle and no phase shift is observed. The results indicate that there is a very poor correlation between boundary layer behavior on a cascade blade and on an actual turbomachine blade. The fact that the stator blade boundary layer is highly unsteady and shows a much larger growth rate than for the cascade casts severe doubt on the reliability of cascade tests in predicting turbomachine blade performance. SD

A78-43916 The unsteady motion of a two-dimensional aerofoil in incompressible inviscid flow B C Basu and G J Hancock (Queen Mary College, London, England) *Journal of Fluid Mechanics*, vol 87, July 12, 1978, p 159-178 8 refs

A numerical method has been developed for the calculation of the pressure distribution, forces and moments on a two-dimensional aerofoil undergoing an arbitrary unsteady motion in an inviscid incompressible flow. In a discussion of the appropriate Kutta condition(s) it is argued that two Kutta conditions are required to obtain a satisfactory solution. The method is applied to (i) a sudden change in aerofoil incidence, (ii) an aerofoil oscillating at high frequency and (iii) an aerofoil passing through a sharp-edged gust.

(Author)

A78-44105 A method of predicting stress corrosion cracking O H Cook, D F Devitt (Vought Corp., Dallas, Tex.), I S Shaffer (U.S. Naval Material Command, Naval Air Development Center, Warminster, Pa.), and J Hoffner (U.S. Naval Air Systems Command, Washington, D.C.) *National Association of Corrosion Engineers, International Corrosion Forum Devoted Exclusively to the Protection and Performance of Materials, Houston, Tex., Mar 6-10, 1978, Paper 17 p*

Results are presented for a program designed to develop a method of predicting SCC in airframe components of naval aircraft exposed to severe marine environment. Aluminum-alloy and low-alloy steel components heat treated to 200 ksi and above are considered. A rating system is proposed based on the parameters affecting the occurrence of SCC. These include alloy/temper, product form, thickness, grain direction, protection systems, shot

penning, assembly and applied sustained stresses and crystallographic orientation. To test the rating system, a correlation is made using Navy and Vought failure history of airframe components. Selected parts from the 'most susceptible' group are reviewed to determine the surface residual stresses by calculation, and verified by using a residual stress analyzer. It is suggested that the rating system can be used during design iterations, so that material or design changes are made before problems arise. SD

A78-44111 Eutectic anodizing of aluminum for extended service life D H Horne *National Association of Corrosion Engineers, International Corrosion Forum Devoted Exclusively to the Protection and Performance of Materials, Houston, Tex., Mar 6-10, 1978, Paper 8 p*

Current methods of coating aluminum aircraft hardware have proven inadequate to prevent shortened operational life due to stress corrosion, pitting, exfoliation, and corrosion related fatigue. In the present paper, chemical, electrochemical, and metallurgical factors which contribute to stress corrosion susceptibility are studied, showing that optimum protection against corrosion-induced failure may be obtained by using a three layer protective coating. Since preparation of the primer and topcoat layers does not pose any major problems, attention is given to the development and optimization of the intermediate layer. It is shown that overaging and loss of strength resulting from anodizing at 300 C can be avoided if a molten eutectic mixture of lithium nitrate and potassium nitrate (which has a melting point of only 108 C) is used as the electrolyte. VP

A78-44113 Coatings for aircraft which operate in marine environments R N Miller and G G Seeliger (Lockheed Georgia Co., Marietta, Ga.) *National Association of Corrosion Engineers, International Corrosion Forum Devoted Exclusively to the Protection and Performance of Materials, Houston, Tex., Mar 6-10, 1978, Paper 8 p*

A test program designed to develop protective coatings for carrier-based naval aircraft fastener areas is described, where the protective system must prevent the entry of corrosive media, must not degrade significantly around stressed fasteners under cyclic flight loads during three years of aircraft operation with repeated exposures to temperatures in the range 54 to 163 C, must be compatible with a chemical pretreatment (over aluminum and titanium) and a subsequently applied white aliphatic polyurethane topcoat, must not be easily damaged in service but, if damaged, will be readily repaired, and must be 0.13 mm or less in thickness with minimum weight consistent with desired performance. The candidate coatings include epoxy polyamide, polysulfide, and polyurethane primers, aliphatic linear polyurethane topcoats, and polysulfide, elastomeric polyurethane, and fluoroelastomeric intermediate coats. Major conclusions are that (1) wet sealing of fasteners with inhibited polysulfide during installation is essential to prevent corrosion, cracking or blistering of the coating, and (2) a three-layer coating system composed of MIL P-23377 epoxy-polyamide primer, elastomeric polyurethane intermediate coat, and aliphatic linear polyurethane topcoat provides good protection for at least four years. SD

A78-44115 Testing of coatings and materials for jet engine components in simulated operational environments W J van der Vet (Nationaal Lucht en Ruimtevaartlaboratorium, Amsterdam, Netherlands) *National Association of Corrosion Engineers, International Corrosion Forum Devoted Exclusively to the Protection and Performance of Materials, Houston, Tex., Mar 6-10, 1978, Paper 9 p* 5 refs

The influence of the operational environment on corrosion of coated jet engine components is discussed, and new test equipment for testing engine components under simulated environmental conditions is described. Cold corrosion and hot corrosion are considered, where the former occurs mainly in the compressor section of jet engines at temperatures up to about 500 C, while the latter occurs in the combustion and turbine sections of jet engines at

temperatures above 750 C Available preliminary data on corrosion testing show that in an aggressive environment, most jet engine materials need a coating in order to increase or maintain component life Overall, the performance of diffusion type coatings on compressor components appears to be superior S D

A78-44146 # **Dynamic analysis of an assembly of shrouded blades using component modes** A V Srinivasan, S R Lionberger, and K W Brown (United Technologies Corp., Pratt and Whitney Aircraft Group, East Hartford, Conn) (*American Society of Mechanical Engineers, Design Engineering Conference, Chicago, Ill., Sept 26-30, 1977, Paper 77-DET-72*) ASME, Transactions, Journal of Mechanical Design, vol 100, July 1978, p 520-527 9 refs

The problem of vibratory behavior of an assembly of shrouded fan blades is examined The point of view that forms the basis for the analysis is that the vibration characteristics of an assembly of blades can be predicted from a knowledge of vibration characteristics of its components Clearly, linear behavior is assumed A viscous type of damping mechanism is included to account for any energy dissipation due to vibratory rubbing action at shroud interfaces As the component modes are computed with a single blade and shroud modelled with plate elements, the extent of chordwise motion in different modes is examined Numerical results of an application of the analysis to a typical fan design are included (Author)

A78-44197 # **The effect of fuel consumption on cost developments (Der Einfluss des Kraftstoffverbrauchs auf die Kostenentwicklung)** B Glockner (Gesellschaft für Internationalen Flugverkehr mbH, Berlin, East Germany) *Technisch-ökonomische Information der zivilen Luftfahrt*, vol 14, no 2, 1978, p 80-83 In German

In connection with the trends of increasing fuel costs, approaches for reducing fuel consumption have become very important for the profitability of airline operations The introduction of new directions for refueling in conjunction with an adherence to favorable flight regimes has made it possible for INTERFLUG, the airline of the German Democratic Republic, to save huge amounts of fuels without violating the requirements of flight safety An investigation is conducted regarding the connection between fuel consumption and cost developments Differences in the fuel prices of different countries are one of several factors which make it difficult to optimize costs The cost of fuel as a part of the flight-time related expenses depends to a very large extent on the route of the aircraft In the case of great price differences, it is customary to obtain additional fuel at places where the prices are low The transportation of a greater amount of fuel, on the other hand, leads to a greater fuel consumption, which has also to be taken into consideration Aspects of fuel consumption in relation to air route and flight time are studied and costs which depend on the time of flight are considered G R

A78-44198 # **The distance measurement procedure DME I (Das Entfernungsmeßverfahren DME I)** W Trempler (Gesellschaft für Internationalen Flugverkehr mbH, Berlin, East Germany) *Technisch-ökonomische Information der zivilen Luftfahrt*, vol 14, no 2, 1978, p 87, 88 In German

The Distance Measurement Equipment (DME) system considered provides information regarding the oblique distance of aircraft to ground reference points The information is supplied in digital form on a continuous basis Since 1959 the DME-based process is used as international standardized procedure The DME system consists of two basic components including the DME interrogator in the aircraft and the DME transponder on the ground The general characteristics of the DME system are considered along with the principle function, the design and operation of the interrogator, the transponder, the technical parameters, an independent DME station, a VOR/DME ground point, DME double installations with two or one supervisor devices, and an individual DME installation G R

A78-44200 # **Titanium and titanium alloys for the maintenance and repair of aircraft II (Titan und Titanlegierungen bei der Instandhaltung und Instandsetzung von Flugzeugen II)** L Ahnert (VEB Kombinat Spezialtechnik, Dresden, East Germany) *Technisch-ökonomische Information der zivilen Luftfahrt*, vol 14, no 2, 1978, p 105-116 17 refs In German

The technological characteristics of titanium and its alloys are considered Titanium belongs to the group of reactive metals These metals are distinguished by their behavior with respect to oxygen, nitrogen, hydrogen, and carbon The entire technology of titanium is significantly different from that of the light metals The complexity of the manufacturing technology for the material and the components made of it are even today often an obstacle for an application of the metal Technological processing techniques for titanium and its alloys are discussed, taking into account aspects of heat treatment, forming operations, welding processes, and surface treatment methods Methods for increasing the corrosion resistance of titanium are based on an oxidation at elevated temperatures and an addition of alloying elements, such as palladium and platinum G R

A78-44224 **Quick bearing strength tests for concrete pavements** I F Scazziga (Eidgenössische Technische Hochschule, Zurich, Switzerland) *Airport Forum*, vol 8, June 1978, p 41, 43-46 6 refs In English and German

A description is given of an approach which makes it possible to conduct rapid tests of the bearing capacity of concrete overlays at different points of airport pavements The conventional method involving the simulation of aircraft loads with the aid of very heavy loading vehicles or loading frames is very costly and time consuming The new approach makes use of a light vibrator which is similar to a device reported by Schwaderer (1970) The vibrator produces a vertical dynamic force of about 2 kN at a frequency of 8 Hz The values for the produced deflection can be calculated on the basis of signals obtained with the aid of five geophones The values derived on this basis are correlated with the deflection measured by the full scale test of the conventional method The new approach makes it possible to limit the conduction of the time-consuming, expensive tests of the conventional method to a few points of a pavement After the quantitative relationship between the values provided by the two tests has been established, it is possible to determine the bearing strength of the remaining areas of the pavement exclusively with the aid of the rapid and inexpensive vibrator test G R

A78-44225 **Computer simulation of terminal utilization** J W Chang, C D Lee, and F Mangano (Ministry of Transport, Ottawa, Canada) *Airport Forum*, vol 8, June 1978, p 63-67 In English and German

The reported computer simulation model has been used to study the strategies of gate assignment and the utilization of the terminal facilities for the contingency planning of airport facilities at many Canadian airports The stages involved in producing a forecast schedule using the model are related to the collection of historical data for the base year, the calibration of the model to the base year data, the collection of forecast data for each future year, and the generation of the forecast schedule Attention is given to a sample forecast, the result of a computer run involving hourly passenger statistics, aircraft mix and seating capacity, sample load ratio and turnaround times, the distribution of the departing passengers during the day, a summary of hourly aircraft statistics, the example of a daily schedule, and the example of a forecast schedule for 1980 G R

A78-44226 **A solar airship - More than a flight of fancy** G Khoury (Imperial College of Science and Technology, London, England) and E Mowforth (Surrey, University, Guildford, England) *New Scientist*, vol 79, July 13, 1978, p 100-102

The development of a solar-powered aircraft is considered The design consists of an aircraft carrying an array of solar cells over most of its surface The cells represent a weight of approximately one

third of the overall envelope. A 20% efficiency in energy conversion is expected along with an airspeed of over 100 km/h for over six hours during the day. Potential energy storage systems include the use of electrolysis to produce hydrogen which would be stored in pods and used to fuel gas turbines. S C S

A78-44268 Ignition of liquid fuel sprays at subatmospheric pressures. D R Ballal (Cranfield Institute of Technology, Cranfield, Beds., England) and A H Lefebvre (Purdue University, West Lafayette, Ind.) *Combustion and Flame*, vol 31, no 2, 1978, p 115-126. 14 refs.

Measurements have been made of the minimum spark energy required by kerosene air mixtures in order to determine the influence of ambient pressure and temperature. The results indicate that (1) liquid fuel sprays require higher breakdown voltage than gaseous fuel-air mixtures, (2) when fuel drops are present in the electrode gap, the electrical energy release is higher than for gaseous mixtures, (3) reduced air pressure, reduced air velocity, and increased SMD spray increase the optimum spark duration, (4) the optimum spark gap width confirms the findings of Ballal and Lefebvre (1977) for gaseous mixtures, (5) the influence of fuel drop size on minimum energy observed for atmospheric pressure also exists at subatmospheric pressure, (6) reduced ambient pressure increases the required spark energy for ignition, (7) increases in mainstream velocity cause increases in the minimum ignition energy, and (8) increases in air temperature and the fuel-air ratio toward the stoichiometric value cause reduced minimum ignition energy. S C S

A78-44357 # Pressure dependence of turbulent jet noise. D-Y Ma, P Z Li, G H Dai, and H Y Wang (Academia Sinica, Institute of Physics, Peking, Communist China) *Acta Physica Sinica*, vol 27, Mar 1978, p 121-125. In Chinese, with abstract in English.

The turbulent noise of a choked jet is examined with reference to the quadrupole radiation of turbulent eddies. It is noted that in a choked jet, the turbulence velocity increases as the stagnation pressure is increased, although the mean jet velocity does not. A general rule relating turbulent velocity to stagnation pressure is derived. D M W

A78-44397 Gust-alleviation control systems for aircraft. D McLean (Loughborough University of Technology, Loughborough, Leics., England) *Institution of Electrical Engineers, Proceedings*, vol 125, July 1978, p 675-685. 32 refs. Research supported by the Science Research Council of England.

The use of active control technology (a.c.t.) to alleviate the effects on both the dynamic and structural responses of an aircraft flying through atmospheric turbulence, while maintaining an acceptable degree of flight-handling qualities, is discussed. Two control schemes, derived from optimal-control theory and the algebraic theory of model following, are presented, and their value as practical methods of achieving satisfactory ride comfort in a gusty environment is discussed. A possible weakness in current methods of mathematical modelling of flexible, or deformable, aircraft is indicated. (Author)

A78-44513 Fatigue of AMg6M sheet material with coatings of Sprut 5M and VAK in the linear and plane stressed conditions under conditions of high-frequency loading. R I Stefanov (*Problemy Prochnosti*, Oct 1977, p 45, 46) *Strength of Materials*, vol 9, no 10, June 1978, p 1197-1199. Translation.

A78-44522 Effect of long service on the fine structure of the surface of gas turbine engine rotor blades. O I Marusi, Iu I Koval', E N Kaspruk, and V N Torgov (Akademiia Nauk Ukrainskoi SSR, Institut Problem Prochnosti, Kiev, Ukrainian SSR) (*Problemy Prochnosti*, Oct 1977, p 103-106) *Strength of Materials*, vol 9, no 10, June 1978, p 1257-1261. 9 refs. Translation.

The influence of the substructure parameters of blade surface layers on the long term fatigue strength characteristics was studied by X-ray metallography techniques. It is shown that most of the structural damage is concentrated in a thin surface layer. The observed nonmonotonic behavior of the fatigue strength is attributed to the directional effect of the surface-layer substructure, characteristic of operation at nonisothermal loads. V P

A78-44612 Criteria of the technical condition of aluminum-alloy coverings with uniform corrosion damage. A I Radchenko and A E Sultanov (Kievskii Institut Inzhenerov Grazhdanskoi Aviatsii, Kiev, Ukrainian SSR) (*Fiziko-Khimicheskaya Mekhanika Materialov*, vol 13, Sept-Oct 1977, p 98-101) *Soviet Materials Science*, vol 13, no 5, July 10, 1978, p 553-555. Translation.

Fatigue tests were performed on 2 mm thick D16 ATV aluminum alloy aircraft sheath specimens subjected to a cyclic tension of 40-45 cycles/min at maximum stresses varying between 13.88 and 22 kg/sq mm. Uniform corrosion damage was produced by 3% NaCl solution. The fatigue life of corrosion-attacked specimens was compared to that of specimens with stress raisers in the form of 1-mm diam holes. The life of corroded specimens fluctuated between 2900 and 260,000 cycles. A least-squares statistical analysis of experimental data yielded airworthiness criteria in the form of correlational equations expressing service life in terms of corrosion depth in percents of initial plate thickness. S D

A78-44616 Alpha Jet. A European aircraft production program with a great future. E Hogenauer and R F Christ *Dornier Post* (English Edition), no 2, 1978, p 15-20.

The organization of the series production for the Alpha Jet, a joint German-French training and light combat aircraft, is described. Production is carried out in approximately equal national shares. With the exception of final assembly, there is no parallel production of the various aircraft components or duplication of production facilities for a given assembly. Belgian industry participates by producing the fuselage nose and landing flaps. The final assembly line at AMD in Toulouse-Colomiers is designed for the French training version, and the line at Dornier in Oberpfaffenhofen is designed for the German fighter bomber version. The principle of one production facility per component is valid also for the powerplant. Some features of the production-optimized construction are discussed, and some of the production equipment and final assembly operations are described. P T H

A78-44617 Alpha Jet - A great leap forward. H Fraidel (Bundesministerium der Verteidigung, Luftwaffe, Cologne, West Germany) *Dornier Post* (English Edition), no 2, 1978, p 25-33.

Some of the design features of the Alpha Jet, a lightweight fighter bomber for close air support, reconnaissance, and helicopter attack, were evaluated by the author/pilot. Positive features are the excellent view in the cockpit and effective ejection seat, an easily viewed instrument layout, problem-free taxiing with or without nosewheel steering, short take-off run and good trimmability, well balanced stability and handling characteristics and light control forces, low fuel consumption even at low altitude, timely stall warning and easy recovery, and high sustained and variable g-loadings. Attention is called to the advanced 'eyes-out' approach with head up display as an integral part of the fire control and navigation system. The aircraft fulfilled all German Air Force operational and logistic requirements. P T H

A78-44618 The ZTL/KEL program in the preliminary phase of future military projects. K-H Dost and G Dostal *Dornier-Post* (English Edition), no 2, 1978, p 34-38.

The paper describes the planning process for future military projects under the Future Technology Air program. Four special working groups constitute the program: (1) systems-oriented overall tasks and suggested solutions, (2) structure and constructional

methods, (3) functional systems and equipment, (4) aerodynamics, thermodynamics, and flight dynamics. Institutionalized departments include authorities such as the Defense Ministry, the evaluation and study facility, industry, and research institutes. The interactions among the working groups and departments are illustrated. Some of the main activities of Dornier in the program are mentioned. These include the development and testing of carbon fiber plastic air brakes, rudders, and elevators, an experimental integrated bad-weather flight control system, and design and construction of a supercritical wing with maneuver flaps. P T H

A78-44619 Wing design for a future airliner. G Binder. *Dornier-Post* (English Edition), no. 2, 1978, p. 46, 47.

The Civil Component Program (ZKP) is concerned with the design of the wing for a new European civil transport aircraft. The lift factor of the ZKP wing is considerably higher than that of the Airbus A 300 for the same Mach number. A method for finding the wing contour for a required pressure distribution at the design point is outlined. For the ZKP wing, a spanwise lift distribution was specified at the design point which provides, on the one hand, the required lift factor and, on the other hand, a low induced drag and optimum stalling behavior. High local lift factors along the span result in pressure distributions with high rear loading and high supercritical pressures, whereby the local supersonic areas are terminated by a shock-free recompression. P T H

A78-44680 Identification of material for AN, MS, and AS engine and propeller standard utility parts and also for company parts. *SAE Aerospace Standard*, AS 269G, Aug. 1, 1977. 6 p.

Material identification codes for aluminum, copper, and titanium alloys, carbon and alloy steels, and corrosion and heat resistant materials are presented for AN, MS, and AS engine and propeller standard utility parts. Distinctions are drawn among parts used in different temperature ranges. D M W

A78-44681 Fire testing of flexible hose, tube assemblies, coils, fittings and similar system components. *SAE Aerospace Standard*, AS 1055B, Mar. 3, 1978. 5 p.

Both fire resistant and fireproof characteristics of flexible hose, tube assemblies, coils, and fittings are reviewed in terms of fire test duration and usage. Flame intensity, air velocity, vibration, and oil flow parameters are regulated to ensure consistency in the test results. It is determined that hardware should not fail by rupture or leakage before a test of 5 min duration to be rated fire resistant, or 10 min to be rated fireproof. D M W

A78-44682 Helicopter fuel economy evaluation. *SAE Aerospace Standard*, AS 1516, Feb. 1978. 1 p.

An accurate determination of helicopter fuel consumption rates is essential to the success of long range missions, e.g., search and rescue, antisubmarine warfare, traffic control, etc. A best range fuel economy equation is presented, and contrasted with an equation for maximum endurance. Attention is given to helicopter weight and fuel flow parameters. D M W

A78-44683 Minimum safe performance over speed warning instruments. *SAE Aerospace Standard*, AS 8007, Feb. 1978. 6 p.

Overspeed warning instruments for use in subsonic aircraft are evaluated in terms of required design criteria, including component compatibility, accessibility, interchangeability, and self-test capability. Accuracy standards for different ambient temperature ranges are given, together with minimum altitude and speed ranges. Required performance parameters for tests of overspeed instruments under standard vibration and weather conditions are listed. D M W

A78-44684 Minimum performance standard for anti-collision light systems. *SAE Aerospace Standard*, AS 8017, Jan. 16, 1978. 7 p.

Effective intensity, flash rate, color, and location about the aircraft are defined for anticollision light systems. Warning lights for three aircraft types (rotorcraft, fixed wing, and fixed wing and rotorcraft) are considered with reference to their required minimum intensities, in candelas. Aviation red and aviation white are defined according to the International Commission on Illumination, and it is noted that flash frequency must not exceed, nor fall below, 100 or 40 flashes per minute, respectively. Finally, performance standards under test conditions designed to simulate the various environments encountered both in flight and on the ground are presented in terms of the following parameters: effective intensity, flash rate, input voltage, and input current. D M W

A78-44685 Aircraft engine fuel pump cavitation endurance test. *SAE Aerospace Recommended Practice*, ARP 492B, Aug. 15, 1977. 10 p.

A reproducible steady-state condition for fuel pump cavitation testing is presented in terms of military engine specifications. It is noted that altitude and climb rate performance are not evaluated in the tests described here. Attention is given to vapor to liquid ratios and mass flow rates. Also outlined are general requirements for fuel composition, fuel pressure, pump speed, test duration, and overall test setup. D M W

A78-44687 Impact protective design of occupant environment transport aircraft. *SAE Aerospace Recommended Practice*, ARP 767A, Jan. 31, 1978. 5 p. 19 refs.

Equipment design factors which may influence the survivability probability of occupants within an aircraft are reviewed, e.g., relative velocity of the impacting equipment and the occupant, impact site on the occupant, direction of the impact, equipment surface roughness, etc. Basic design criteria aimed at reducing impact injury are discussed, including soft padding of instrument housing, collapsible hard structures, recessing of switches and knobs, and the reduction of failing distance for arms and legs under conditions of turbulence or crash. D M W

A78-44688 Preferred electrical connectors for aerospace vehicles and associated equipment. *SAE Aerospace Recommended Practice*, ARP 1308A, Oct. 1977. 13 p.

The goal of maximum utility from a minimum of electrical connectors in aerospace applications is examined with reference to cylindrical or rectangular connectors of standard, miniature, or subminiature dimension. Military specifications for the connectors are reviewed, and tables are presented listing connector types with their corresponding function. D M W

A78-44689 Type measurements of aircraft interior sound pressure levels in cruise. *SAE Aerospace Recommended Practice*, ARP 1323, Feb. 1978. 6 p. 9 refs.

Recommended design and operating criteria pertaining to the acoustical environment of passenger aircraft are presented. The frequency response parameters of the total acoustical system (comprising microphone, recording, and data reduction systems) are described, e.g., flat within plus or minus 3 dB over the frequency range from 45 Hz to 11.2 kHz. Requirements for the calibration of the system are discussed in terms of measurement location and test conditions. D M W

A78-44691 Minimum requirements for future wide-body aircraft cargo systems and compartments. *SAE Aerospace Recommended Practice*, ARP 1395, Feb. 1978. 17 p.

Recommended design criteria for civil wide-body freighter aircraft equipment such as main deck unitized handling and restraint systems are presented with attention to 2.44 m wide, multiple bottom configuration Unit Load Devices (ULDs). Various types of certified ULDs are listed, together with their ancillary equipment,

e.g., guidance, powered movement, stick loading, conveyance, etc. Required environmental parameters for ULDs are also discussed, e.g., temperature, pressure, vibration and noise levels, ventilation, etc. D M W

A78-44692 **Requirements for aircraft on board weight and balance system** SAE Aerospace Recommended Practice, ARP 1409, Jan 1978 5 p

Function and operating characteristics for an on board weight and balance system (OBWBS) for civil aircraft are reviewed. Requirements for OBWBS are listed as follows: determination and display of aircraft weight in the range from 10% less than empty to 10% greater than maximum gross taxi weight, determination of maximum center of gravity range and lateral center of gravity, and automatic compensation of pitch and roll changes. The required parameters of the display unit are described, e.g., system weight of no more than 22.7 kg, lighted digits of at least 0.64 cm, power consumption of 500 W max, etc. D M W

A78-44693 **Pneumatic ground power supplies for starting aircraft** SAE Aerospace Information Report, AIR 944A, Jan 15, 1978 36 p

The report gives descriptive information and performance data on pneumatic ground power supplies of different configurations for starting aircraft engines. The power supplies are classified into power limited and capacity-limited type. The first type of power supply is a true prime mover and can provide pneumatic power continuously for unlimited periods of time, most of these units are either gas turbine bleed, gas turbine-driven compressor, or reciprocating engine-driven compressor. The second type of power supply is such that either air compressed and stored at high pressure, or liquid nitrogen stored in cryogenic tanks, is expanded to perform the aircraft starting function or the recharge pneumatic storage tanks on board the aircraft, this type of power may or may not contain a prime mover, depending on the vehicle configuration. The material presented is intended for general use by the aircraft and airline industries to assist in the selection and utilization of pneumatic power supplies. The manufacturers mentioned are included for reference purposes only. S D

A78-44696 **Fault isolation in environmental control systems of commercial transports** SAE Aerospace Information Report, AIR 1266, Aug 1977 31 p 8 refs

The design and use of fault isolation equipment for commercial transport aircraft are discussed. Various methods of fault isolation are described including manual built in test equipment, ground support equipment, and software programs. Primary aspects of detail trade-off studies are noted such as effectiveness, costs, reliability, development, risk, space allocation, weight, and crew workload. Procedures for conducting a tolerance study are outlined along with major hardware and software considerations. Prospects for future fault isolation equipment are identified including system readiness and performance testing, the monitoring of system degradation, and corrective maintenance signalling. S C S

A78-44699 **Electromagnetic compatibility on gas turbine engines for aircraft propulsion** SAE Aerospace Information Report, AIR 1423, Aug 1977 8 p 10 refs

The paper discusses the compatibility of the electrical and electronic systems of gas turbine engines used for aircraft propulsion. Recommendations for electromagnetic compatibility are considered with reference to the design of system components and the interconnecting wiring, emission power circuit requirements, signal and control requirements, and special conducted susceptibility testing. Radiated emission characteristics are described and recommended control documents are identified. S C S

A78-44700 **Methods of achieving electromagnetic compatibility of gas turbine engine accessories, for self-propelled vehicles** SAE Aerospace Information Report, AIR 1425, Mar 1978 7 p 16 refs

Techniques to achieve electromagnetic compatibility of gas turbine engine accessories are reviewed, noting emission and susceptible accessories. The charting of a complete turbine energy accessory system is discussed along with the derivation of the frequency spectrum in sinusoidal waveform via Fourier analysis. The applications of photographs of voltage and current waveforms for emission analyses, and of signal generators and commercial power amplifiers for susceptibility studies are noted. S C S

A78-44701 **Verification of landing gear design strength** SAE Aerospace Information Report, AIR 1494, Feb 1978 2 p

A verification of test procedures used to design landing gear for a wide variety of aircraft (large and small, fixed-wing and rotor, civil and military) are reviewed with attention to analyses conducted prior to first flight. Among the factors considered are static and fatigue characteristics of all primary structural elements, brake energy dissipation, nose and main gear shimmy stability, and loading and response parameters for the steering system. Additional criteria for final design approval are also presented, including complete drop tests through the reserve energy condition, fatigue spectrum tests for the final configuration, and retraction/extension life cycle tests. D M W

A78-44703 **EMC antennas and antenna factors** How to use them SAE Aerospace Information Report, AIR 1509, Jan 1978 23 p 7 refs

The present aerospace information report discusses the use and applications of EMC antennas and antenna factors. The relationships between antenna gain, antenna factor, power density (W/sq m) and field strength (V/m) are examined. Illustrations of commercially available EMC antennas commonly used in performing EMI measurements are included. Lists of antenna factors, frequency ranges, typical applications, and antenna manufacturers are provided. S D

A78-44705 **Report on aircraft engine containment** SAE Aerospace Information Report, AIR 1537, Oct 1977 42 p

Results are presented for a technical study of aircraft gas turbine noncontainment for the period January 1, 1962 through December 31, 1975. Noncontained failure of an aircraft turbine engine is defined as any failure which results in the escape of rotor fragments through the nacelle cowling or through panels which isolate the propulsion installation from the remainder of the aircraft structure. The term rotor includes rotating structural components such as disks, spacers and blades. Rotor failures of primary importance in the technical study are those which release fragments of sufficient energy to constitute a potential hazard to the aircraft through damage to other systems or structure outside the affected propulsion system. The study permitted classifying incidents by cause and effect to identify areas of greatest concern and recommending areas for greatest potential improvement. Pertinent tables and diagrams for noncontained failure events of different classes are presented. S D

A78-44706 **Beryllium 1977, International Conference, 4th, London, England, October 4-7, 1977, Conference Preprints** Conference sponsored by the Metals Society and Institution of Metallurgists. London, Metals Society, 1977 685 p \$36 40

The papers describe studies on the correlation between mechanical properties and microstructure of beryllium and its alloys, techniques of forming beryllium and its alloys, and applications of beryllium. Individual topics investigated include microplasticity in hot-pressed beryllium, effect of oxide and grain size in high-purity beryllium, strength-ductility relationships in intermediate purity hot-pressed beryllium, properties and yield behavior of hot machined beryllium, the nature of plasma sprayed beryllium and the effect of

heat treatment, adhesive bonding of beryllium structural components, and spectroscopic determination of atmospheric beryllium

P T H

A78-44736 # Beryllium in aircraft brakes - A summary S Zenczak (Brush Wellman, Inc., Cleveland, Ohio) In *Beryllium 1977*, International Conference, 4th, London, England, October 4-7, 1977, Conference Preprints London, Metals Society, 1977, p 50/1-50/5

The development of beryllium aircraft brakes is outlined. The design of beryllium brake is examined from the standpoints of friction to friction concept, metallurgy, mechanics (drive lugs, expansion slots), thermodynamics, corrosion, and rework capability. The characteristics of three beryllium aircraft brakes of different configurations, which are in production, are presented. It is shown that beryllium exhibits a much better performance than anticipated during the initial design phase, and that beryllium is an engineering material which can perform well in some very severe service conditions

S D

A78-44799 # In-flight utilization of aircraft radio-navigation instruments (Letnaia ekspluatatsiia radionavigatsionnogo oborudovaniia samoletov) I E Bondarchuk Moscow, Izdatel'stvo Transport, 1978 272 p In Russian

Means for assuring the reliability of aircraft navigation instruments are discussed, with attention given to the technical servicing and in-flight utilization of such instruments. The principles of operation and utilization characteristics of such instruments and systems as radio compasses, radio altimeters, landing systems, direction finders (compatible with beacons and ILS), Shoran, and autonomous navigation systems are considered

B J

A78-44806 # Onboard radio-navigation and landing aids for aircraft (Radioustroistva bortovykh navigatsionnykh i posadochnykh kompleksov samoletov) A A Sosnovskii and I A Khaimovich Moscow, Izdatel'stvo Transport, 1977 216 p 86 refs In Russian

Consideration is given to the design and principles of operation of onboard navigation and landing systems for civil transport aircraft. Particular attention is given to such systems as Loran, Shoran, ILS, and VOR/DME. Low-altitude radio altimeters and Doppler angle and velocity meters are also discussed

B J

A78-44823 Integrated time, cost, and performance planning in aircraft development - Computer-aided project management in the development and construction of a modern aircraft (Integrierte Zeit-, Kosten- und Leistungsplanung in der Flugzeugentwicklung - Rechnerunterstütztes Projektmanagement bei der Entwicklung und Konstruktion eines modernen Flugzeuges) W Herbst (Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn, West Germany) In *Weapon systems planning* Systems engineering formulations and contributions Munich, R Oldenbourg Verlag GmbH, 1977, p 355-376 10 refs In German

The complexity of the aircraft development process is considered. A significant part of the total development costs is now related to technical management and coordination tasks. In spite of the effort devoted to management objectives, there have arisen, in a number of cases, technical and financial problems which have apparently their origin in an insufficient recognition of the complex interactions of the involved technical relationships. An investigation is in this connection conducted concerning the possibilities for the solution of this problem with the aid of electronic data processing techniques. The basic relationships between technology, costs, and deadlines are examined and the various types of management procedures are considered. It is found that the currently used management procedures do not provide a capability for an immediate control of technical performance and a direct guidance of the technical activities of development engineers and designers. A new approach which is to provide this capability is discussed. The

approach makes use of a system which includes a central computer, a data bank, graphic display devices, and a high-speed printer

G R

A78-44830 # Minimum-time loop maneuvers of jet aircraft S Uehara, H J Stewart, and L J Wood (California Institute of Technology, Pasadena, Calif.) *Journal of Aircraft*, vol 15, Aug 1978, p 449-455 35 refs

Minimum time loop maneuvers of jet aircraft are investigated by means of the calculus of variations. The optimal control (lift coefficient and thrust) is determined as a function of the state variables and Lagrange multipliers for an arbitrary maneuver in the vertical plane. Intermediate thrust arcs and intermediate lift arcs with minimum thrust are shown to be nonoptimal for the dynamic models considered. Rules are established for joining trajectory segments with different types of control behavior. Using these results, optimal loop trajectories are generated for a given set of initial conditions and a large number of values of maximum lift coefficient and maximum thrust. The control history and the maneuver time are found to be strongly affected by the latter two parameters. Two aerodynamic models are considered, one relatively simple and the other somewhat more complicated

(Author)

A78-44831 # Minimum trimmed drag and optimum c g position G Sachs (Munich, Hochschule der Bundeswehr, Neubiberg, West Germany) *Journal of Aircraft*, vol 15, Aug 1978, p 456-459 12 refs

An analytical expression is developed which shows that wing/tail interference drag is determined by wing downwash at downstream infinity. With the use of this expression, relations for minimum trimmed drag and optimum c g position are presented in explicit form. From this it follows that minimum induced drag is less for the combination of wing-plus tail than for the wing alone. It is shown that this is true even for the case when the optimum tail load is a download rather than an upload. Furthermore, it is shown which are the factors that have a decisive effect on optimum c g position

(Author)

A78-44832 # Surface pressure measurements at the tip of a model helicopter rotor in hover T P Shivananda, H M McMahon, and R B Gray (Georgia Institute of Technology, Atlanta, Ga.) *Journal of Aircraft*, vol 15, Aug 1978, p 460-467 12 refs Grants No DA ARO(D)-31 124 73-G184, No DAAG29-76 G-0007

Detailed blade-tip surface pressure distribution data for a single-bladed model helicopter rotor in hover are presented. The pressure measurements were made along the chordwise direction at six spanwise stations out-board of the 94% radial location on the rotor blade. Data were taken at blade collective pitch angles of 0, 6.2, and 11.4 deg at Reynolds numbers (based upon rotor tip speed and chord) of 5.44×10^6 to the 5th and 7.36×10^6 to the 5th. The points of inception of the primary vortex inferred from the pressure data agree with those noted by other investigators using surface flow visualization techniques. The presence of both a primary and a secondary vortex near the rotor tip at a pitch angle of 11.4 deg is observed. Normal and chordwise force coefficients obtained by integrating the pressure data are also presented

(Author)

A78-44833 # Fountain and upwash flowfields of multijet arrangements F A Wohllbe and M J Siclari (Grumman Aerospace Corp., Bethpage, N Y.) *Journal of Aircraft*, vol 15, Aug 1978, p 468-473

A series of cold gas experiments was performed to determine the characteristics of the upwash and fountain regions of multijets exhausting normal to a ground plane. Detailed total pressure surveys were taken in lateral and vertical planes for both two-jet upwash and three-jet fountain flows. Fountain measurements are presented which depict the gradual formation of coalescent fountain flow from its constituent two-jet upwash flows. Flow visualizations of the ground and vertical planes of symmetry are presented for three-jet fountain flow. Stagnation line behavior under conditions of asymmetry were achieved by rotating the ground plane. Comparisons with a semi-empirical prediction methodology are also presented

(Author)

A78-44834 # Gust response of a wing near the ground through the lifting surface theory M Kobayakawa and H Maeda (Kyoto University, Kyoto, Japan) *Journal of Aircraft*, vol 15, Aug 1978, p 520-525 8 refs

The ground effect on the gust response of wings is investigated theoretically and experimentally. In the theoretical calculations the lifting surface theory is applied. The ground effect terms are added to the ordinary kernel function. The gust response functions are calculated for three rectangular wings of different aspect ratio and one delta wing. The augmentation of the response function by the ground effect appears as the wing approaches the ground. Furthermore, experiments of the ground effect on the wings are performed by wind tunnel tests. Comparison between experimental values and theoretical results shows good agreement (Author)

A78-44835 # An experiment on the gust response of a transport airplane by free-flight model M Kobayakawa and H Maeda (Kyoto University, Kyoto, Japan) *Journal of Aircraft*, vol 15, Aug 1978, p 540, 541 5 refs

The gust response of a medium-sized jet transport was examined on the basis of free flight experiments performed using a dynamically similar model. The model was launched horizontally, when it reached steady flight conditions, an impulsive vertical gust was encountered. The acceleration of the model was acquired by an onboard g meter through telemetry. Since the flight speed was constant, experimental parameters were the gust velocity and the width of the gust velocity profile. The results do not agree with theoretical values and the effect of the elastic distortion of the wing exceeded expectations

B J

A78-44836 # Some nonlinear effects in stability and control of wing-in-ground effect vehicles R Staufenbiel (Rheinisch Westfälische Technische Hochschule, Aachen, West Germany) *Journal of Aircraft*, vol 15, Aug 1978, p 541-544 10 refs

When a three dimensional wing is flown close to the ground, it experiences a decrease in induced drag and an increase in lift curve slope together with a nose down pitching moment. The present paper examines the longitudinal motion of this type of wing-in-ground (WIG) effect vehicle. At very low heights the aerodynamic coefficients in the longitudinal equations of motion are essentially nonlinear functions of height and angle of attack. Quasi-linear motion is used for a general description of static and dynamic stability in ground effect, while important nonlinear effects in the stability and control of a WIG vehicle are investigated without any linearization

B J

A78-44850 # Three-dimensional hypersonic gas flow past a thin wing (Prostranstvennoe obtekanie tonkogo kryla giperzvukovym potokom gaza) V I Bogatko, A A Grib, and G A Kolton (Leningradskii Universitet, Vestnik, Matematika, Mekhanika, Astronomiya, Apr 1978, p 158-160 6 refs In Russian)

Chornyi's thin shock-layer method (1959) is used to solve the problem of the hypersonic flow of an ideal gas past a thin wing of finite aspect ratio at angle of attack. It is assumed that the ratio of gas densities at the reattached head shock front is small with respect to unity

B J

A78-44893 # The effect of hydraulic feed systems on the dynamic characteristics of hydraulic amplifiers of helicopter control systems (Vliianie gidrosistemy pitaniia na dinamicheskie kharakteristiki gidrosistemy sistem upravleniia vertoletov) V S But'ko, V Iu Gurban, G I Zaionchkovskii, G M Kondrashov, V N Kuznetsov, and Ia N Peiko *Pneumatika i Gidravlika* no 5, 1978, p 107-115 7 refs In Russian

The paper presents results of theoretical and experimental studies of the effect of pressure oscillations in the feed system of a hydraulic amplifier with constant delivery pump on the dynamic characteristics of a helicopter control system. It is found that pressure oscillations arising under typical flight conditions lead to an increase in the oscillation level (by 1.4-1.5 times) of the control system, which results, in turn, in degradation of the dynamic

characteristics of the system. The use of variable-delivery pumps is considered as one way to remedy this problem B J

A78-44909 # Simplified formulas for lift and moment in unsteady thin airfoil theory N H Kemp (Physical Sciences, Inc., Woburn, Mass.) *AIAA Journal*, vol 16, Aug 1978, p 851, 852

The study reveals that the formula for the moment of an arbitrary oscillatory motion in subsonic thin airfoil theory takes a remarkably simple form when reformulated in a coordinate system originating at the airfoil center, with pitching taken about that center. An equation for lift and an equation for nose-down moment about the airfoil center are derived which are versions of Williams' (1977) results. It is shown that in the centered coordinate system considered, not only lift and moment for arbitrary motion are determined only by the loadings for plunging and pitching, but the lift depends only on the plunging loading and the moment only on the pitching loading. This seems a useful reformulation of Williams' results S D

A78-45001 # Investigation of phenolic antioxidants in the stabilization of T-7 fuel (Issledovanie fenol'nykh antioksidantov pri stabilizatsii topliva T-7) S N Terekhin, T P Vishniakova, I A Golubeva, and E V Glebova (Moskovskii Institut Neftokhimicheskoi i Gazovoi Promyshlennosti, Moscow, USSR) *Khimiia i Tekhnologiya Topliv i Masel*, no 7, 1978, p 11, 12 In Russian

The effect of seven phenolic antioxidant additives on the stability of T-7 fuel was studied on the basis of the quadrupole heating method. All the additives lead to an improvement in the antioxidative stability of the fuel, but the acid content of the fuel remains the same as before heating, optical density and sedimentation of the fuel increases negligibly. Consideration is also given to the efficiency of phenolic additives under conditions of developed oxidation (the concentration of additives was 0.001 by mass percent) B J

A78-45067 # Lasers in aviation (Lazery v aviatsii) V L Sterligov (Moscow, Izdatel'stvo Transport, 1977 80 p In Russian)

This work gives a popular account of current and potential aerospace applications of lasers. Particular attention is given to gasdynamic-laser engines, laser radar, orbital laser rangefinders, laser altimeters, laser gyros, laser landing systems, and laser photography. Consideration is also given to some ground based applications of lasers, including communications and environmental monitoring B J

A78-45095 * # Real time digital propulsion system simulation for manned flight simulators J R Mihalow and C E Hart (NASA, Lewis Research Center, Cleveland, Ohio) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-927 44 p 7 refs*

The QCSEE (Quiet, Clean Short haul Experimental Engine) Program was initiated by NASA to develop and demonstrate propulsion system technology for an advanced commercial STOL aircraft. One of the specific technical objectives was to provide technology for digital electronic control of future commercial engines. An element of this technology development was to evaluate the digital control in a simulated flight environment. In this connection a simulation program was initiated to evaluate the QCSEE UTW (Under-the-Wing) digital control system over a range of conditions encountered in typical airport operations. The goal of the simulation effort was to derive a real time digital propulsion simulation which could be integrated into a multiengine aircraft simulation. A summary is provided of the accomplishments which have been made in this program G R

A78-45096 * # Inlet-engine matching for SCAR including application of a bicone variable geometry inlet J F Wasserbauer and W H Gerstenmaier (NASA, Lewis Research Center, Cleveland, Ohio) *American Institute of Aeronautics and Astronautics and*

Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-961 22 p 15 refs

Airflow characteristics of variable cycle engines (VCE) designed for Mach 2.32 can have transonic airflow requirements as high as 1.6 times the cruise airflow. This is a formidable requirement for conventional, high performance, axisymmetric, translating centerbody mixed compression inlets. An alternate inlet is defined where the second cone of a two cone centerbody collapses to the initial cone angle to provide a large off-design airflow capability, and incorporates modest centerbody translation to minimize spillage drag. Estimates of transonic spillage drag are competitive with those of conventional translating centerbody inlets. The inlet's cruise performance exhibits very low bleed requirements with good recovery and high angle of attack capability. (Author)

A78-45097 * # Fuel consumption improvement in current transport engines. R. W. Hines (United Technologies Corp., Pratt and Whitney Aircraft Group, East Hartford, Conn.) and J. A. Ziemianski (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-930* 7 p 7 refs. Contracts No. NAS3-20630, No. NAS3-20632.

A review is conducted of improvements which can be made with respect to the fuel consumption of current engines and new production versions of current engines. A description is presented of an engine diagnostics program which has the objective to identify and quantify the causes and sources of performance deterioration in the JT9D turbofan engine and to develop basic data which will be applied to minimize performance degradation of current and future engines. General areas where performance losses occur are examined, taking into account seals, blades and vanes, and cases. Potential performance improvement concepts are related to improved component aerodynamics, improved flowpath sealing, blade tip clearance control, improved turbine cooling effectiveness, improved turbine materials and coatings, duct and nozzle aerodynamic refinements, nacelle aerodynamic refinements, forced exhaust mixers, advanced nacelle materials, and advanced fuel control. (G.R.)

A78-45098 * # NASA/General Electric Engine Component Improvement Program. A. J. Albright, D. J. Lennard (General Electric Co., Cincinnati, Ohio), and J. A. Ziemianski (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Joint Propulsion Conference, 14th, Las Vegas, Nev., July 25-27, 1978, AIAA Paper 78-929* 7 p. Contracts No. NAS3-20629, No. NAS3-20631.

The Engine Component Improvement (ECI) Program has been initiated in connection with projects designed to reduce the impact of the world wide energy crisis in the area of aviation. The two parts of the ECI program have the overall objective to identify and quantify the sources and causes of CF6 engine performance deterioration, and to reduce the fuel consumption of CF6 engines through the development and the incorporation of various performance improvement concepts. The CF6 high bypass turbofan engine was selected as a basis for this effort, since it is expected to be a significant fuel user in commercial revenue service for the next 15 to 20 years. The first part of the ECI program represents the initial step in an effort to achieve a goal of five percent reduction in fuel usage for CF6 engines in the 1979-82 time period. The first performance improvement concept selected is an improved efficiency fan blade. Other improvements are related to a short core exhaust system and an improved high pressure turbine. (G.R.)

A78-45118 # Correlation of the errors of the Omega radio navigation system (Korrelatsiya mezhdu oshibkami radionavigatsionnoi sistemy 'Omega'). B. Lorchinskiy (Odesskoe Vysshee Inzhenernoe Morskoe Uchilishche, Odessa, Ukrainian SSR). *Geodeziya i Aerofotos'emka*, no. 1, 1978, p. 30-34. 9 refs. In Russian.

In the present paper, extensive recorded Omega measurements are analyzed to evaluate the precision of the system. The autocorrelation functions and cross correlation functions of the Omega system are determined and discussed. The autocorrelation function expresses the stochastic relationship of the errors of successive discrete and continuous measurements carried out at one pair of stations. The cross correlation function expresses the stochastic relation of the errors of such measurements at two pairs of stations. (V.P.)

A78-45119 # Optimal data processing for the Decca radio navigation system (K voprosu optimal'noi obrabotki dannykh favozoi radionavigatsionnoi sistemy 'Dekka'). L. L. Bagushchenko (Odesskoe Vysshee Inzhenernoe Morskoe Uchilishche, Odessa, Ukrainian SSR). *Geodeziya i Aerofotos'emka*, no. 1, 1978, p. 35-39. In Russian.

In the present paper, the Kalman filter method is applied to the processing of Decca data. The data are optimized by simulating the process on a digital computer. An analysis of the influence of a number of factors on the data revealed some unfavorable features caused by dead reckoning errors as well as by the inaccuracy of the statistical models. The Kalman filter formulas are used to obtain corrections to ship coordinates and the ship's velocity components on the basis of processed Decca data. (V.P.)

A78-45124 # Method of calculating the landmark density of aeronautical charts (Metodika rascheta nagruzki aerornavigatsionnykh kart). V. S. Elizarov. *Geodeziya i Aerofotos'emka*, no. 1, 1978, p. 131, 132. In Russian.

Existing aeronautical charts have been prepared without considering the psychophysiological capabilities of the navigator and the influence of the aircraft's angular velocity. In the present paper, a method is proposed for calculating the proper number of landmarks on aeronautical charts intended for high speed aircraft, making allowance for the psychophysiological capabilities of the navigator, the flying height and speed, and the theoretical aspects of image detection. (V.P.)

A78-45127 * # A new method for designing shock free transonic configurations. H. Sobieczky, N. J. Yu, K.-Y. Fung, and A. R. Seebass (Arizona, University, Tucson, Ariz.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 11th, Seattle, Wash., July 10-12, 1978, Paper 78-1114* 35 p. 21 refs. Grants No. AF-AFOSR-76-2954E, No. NSG-2112, Contract No. N00014-76-C-0182.

A new method for the design of shock-free supercritical airfoils, wings, and three-dimensional configurations is described. Results illustrating this procedure in two and three dimensions are given. They include modifications to part of the upper surface of an NACA 64A410 airfoil that will maintain shock free flow over a range of Mach numbers for a fixed lift coefficient, and the modifications required on part of the upper surface of a swept wing with an NACA 64A410 root section to achieve shock-free flow. While the results are given for inviscid flow, the same procedures can be employed iteratively with a boundary layer calculation in order to achieve shock-free viscous designs. With a shock-free pressure field the boundary layer calculation will be reliable and not complicated by the difficulties of shock-wave boundary layer interaction. (Author)

A78-45128 # Study of pitot-type supersonic inlet-flowfields using the finite-volume approach. A. W. Rizzi and W. Schmidt (Dornier GmbH, Friedrichshafen, West Germany). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 11th, Seattle, Wash., July 10-12, 1978, Paper 78-1115* 9 p. 14 refs. Bundesministerium der Verteidigung Contract No. T/RF-42/80001/81400.

An efficient numerical method for calculating axisymmetric pitot-type inlet flow fields at supersonic free stream Mach numbers is presented. It is the second-order-accurate time dependent finite volume procedure that solves the Euler equations in integral conservation-law form. These equations are written with respect to a Cartesian coordinate system in which a body and bow shock fitted mesh adjusts in time to the motion of the bow shock that is

automatically captured as part of the weak solution. At the fixed boundary inside the lip static pressure is described as subsonic boundary condition. The scheme uses the time splitting concept to accelerate the convergence. Comparisons are made between computed results using the present method and other theories as well as experimental results. (Author)

A78-45134 # Mach number and temperature effects on jets J C Lau (Lockheed-Georgia Co., Marietta, Ga.) *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 11th, Seattle, Wash., July 10-12, 1978, Paper 78-1152* 10 p. 14 refs. Contract No. F33615-76-C-2021

The reported investigation has the aim to improve the understanding of the various factors which influence jet noise production. The studies have been carried out over a range of jet conditions which extends to supersonic Mach numbers and jet temperatures of over two times that of the ambient. It was found that the spreading rate of the mean velocity distributions generally falls with increasing Mach number for jet temperature ratios up to about 1.5. At a Mach number which appears to be associated with the eddy convection velocity being supersonic, the spreading rate undergoes a change and rises with increasing Mach number. The spreading rate of the jet heated to a temperature ratio of 2.32 does not change substantially with Mach number and its distribution intersects those of the lower temperature jets at about Mach 1.0. G R

A78-45138 # Probe measurements of velocity and losses from a small axial transonic rotor R P Shreeve, F J Dodge, W R Hawkins, and V J Larson (U S Naval Postgraduate School, Monterey, Calif.) *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 11th, Seattle, Wash., July 10-12, 1978, Paper 78-1198* 55 p. 15 refs. Navy-supported research

The use of a combination temperature pneumatic probe downstream of the rotor of a small compressor is reported. The design and a general method for representing the calibration of the probes are given. Corrections for boundary (or immersion) effects were shown to be small, as a result of the chosen sensor geometry. The temperature recovery factor of the fine wire thermocouple sensor, used differentially, was close to 0.9 and was insensitive to Mach number. Procedures and programs to obtain the distribution of rotor blade performance parameters were developed and examples of velocity, static pressure and loss distributions are given. (Author)

A78-45143 # Nonlinear aerodynamics of wing-body combination E H Atta and A H Nayfeh (Virginia Polytechnic Institute and State University, Blacksburg, Va.) *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 11th, Seattle, Wash., July 10-12, 1978, Paper 78-1206* 14 p. 46 refs. Grant No. DAAG29-76-G-0034

A method for calculating the steady nonlinear aerodynamic characteristics of wing-body combinations at low subsonic speeds is developed. The method uses a potential flow model consisting of constant strength quadrilateral vortices distributed over the wing and body surfaces. The method accounts for separation from the lifting-surface (wing, canard, tail) edges and for interference effects due to the presence of the body, however, it does not account for separation from the body. Total and distributed loads are predicted and compared with available experimental data as well as other theoretical models. Numerical examples are presented to demonstrate the versatility of the method for handling a variety of configurations. Limitations and extensions of the method to more general and complex flows are also discussed. (Author)

A78-45148 * # Theoretical and experimental study of the drag of multielement airfoils L E Olson (NASA, Ames Research Center, U S Army, Aeromechanics Laboratory, Moffett Field, Calif.), W D James (Iowa State University of Science and Technology, Ames, Iowa), and P R McGowan (Computer Sciences Corp., Mountain View, Calif.) *American Institute of Aeronautics*

and Astronautics, Fluid and Plasma Dynamics Conference, 11th, Seattle, Wash., July 10-12, 1978, Paper 78-1223 12 p. 17 refs.

The viscous/potential flow past single-element and multielement airfoils is studied theoretically and experimentally. A computerized analysis, based on iteratively coupled potential-flow and boundary-layer analysis, is used to predict the flow field of the airfoil. The method yields detailed characteristics of conventional laminar and turbulent boundary layers, turbulent wakes, and confluent boundary layers. The viscous flows are analyzed with a method that uses finite-difference solutions of the boundary-layer equations. Reynolds stress in the boundary layers and wakes is simulated with eddy viscosity models for the various flow zones. The viscous calculations are carried into the wake of the airfoil where the drag is found from the defect in the wake momentum. (Author)

A78-45149 * # Upgraded viscous flow analysis of multi-element airfoils G W Brune and J W Manke (Boeing Co., Seattle, Wash.) *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 11th, Seattle, Wash., July 10-12, 1978, Paper 78-1224* 9 p. 19 refs. Research supported by the Boeing Co., Contract No. NAS1-14522

A description of an improved version of the NASA/Lockheed multielement airfoil analysis computer program is presented. The improvements include several major modifications of the aerodynamic model as well as substantial changes of the computer code. The modifications of the aerodynamic model comprise the representation of the boundary layer and wake displacement effects with an equivalent source distribution, the prediction of wake parameters with Green's lag-entrainment method, the calculation of turbulent boundary layer separation with the method of Nash and Hicks, the estimation of the onset of confluent boundary layer separation with a modified form of Goradia's method, and the prediction of profile drag with the formula of Squire and Young. The paper further describes the modifications of the computer program for which the structured approach to computer software development was employed. Important aspects of the structured program development such as the functional decomposition of the aerodynamic theory and its numerical implementation, the analysis of the data flow within the code, and the application of a pseudo code are discussed. (Author)

A78-45150 # Two element airfoil systems designs - An inverse method G Volpe (Grumman Aerospace Corp., Bethpage, NY.) *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 11th, Seattle, Wash., July 10-12, 1978, Paper 78-1226* 11 p. 13 refs. Contract No. N00014-75-C-0722

A procedure for generating airfoil-slat or airfoil-flap systems corresponding to given pressure distributions at transonic speeds is described. The design of the two-element airfoil system is achieved through sequential modifications of a pair of initial profiles. The required modifications are arrived at by numerically solving the full potential equation, with the use of mixed-flow relaxation procedures, for the flow field about the current profiles with Dirichlet boundary conditions. Both the full design problem, where the entire configuration is to be constructed, and the mixed design problem, where only one of the airfoils or segments of either are to be altered, are discussed, as are several design cases and their results. (Author)

A78-45158 # Investigation of the accuracy of one-way range measurements (Issledovanie tochnosti odnopushevogo metoda izmereniia dal'nosti) Iu S Iurchenko *Radioelektronika*, vol. 21, May 1978, p. 65-70. 7 refs. In Russian

The technique of one-way range measurement in radio navigation systems is based on the use of highly stable frequency standards. A one-way rangefinder system requires periodic correction of errors associated with phase instability of the oscillators. The present paper examines the feasibility of increasing the accuracy of the one-way technique by constructing a complex rangefinder, consisting of one-way and correcting channels. Consideration is given to cases when the correction interval is equal to one and to several periods of pulse input to the one-way channel. B J

A78-45172 # Isoperimetric problems of the theory of supercavitated mechanisms (Izoperimetricheskie zadachi teorii superkaviruiushchikh mekhanizmov) V M Ivchenko (Krasnoyarskii Politehnicheskii Institut, Krasnoyarsk, USSR) *Gidromekhanika*, no 38, 1978, p 85-89 11 refs In Russian

In the present paper, some isoperimetric problems for such supercavitated mechanisms as wings, propellers, pumps, hydraulic turbines, etc., are formulated for use in designing optimal fully-cavitated hydrofoils. Some basic and supplementary (penalty) conditions for a marine supercavitated actuator are derived on the basis of numerical estimates and speculative considerations V P

A78-45218 Airborne television transmission M W Harman and J Middleton (British Broadcasting Corp., Research Dept., Tadworth, Surrey, England) *BBC Engineering*, Apr 1978, p 26-37

The use of high flying aircraft or captive balloons for airborne television transmission is discussed with reference to VHF reengineering. While the U K has no plans for reengineering at present, the conversion of the system that transmits 405 line black-and-white to a system that transmits 625 line color is possible in the future, and one approach would be to transfer 405-line transmission to captive balloons while the earth-based system is modified. The paper describes studies of propagation effects of transmitting from high-altitude aeriels, tests were conducted at 224 MHz Band III service area prediction, cochannel interference, and channel allocations are examined, and a plan for the United Kingdom is outlined. Approximate cost comparisons are presented for different methods of transmission M L

A78-45226 # Calculation of transonic flows around wings (Calcul d'écoulements transsoniques autour d'ailes) J J Châtot, C Coulombeix, F Manie, and V Schmitt (ONERA, Châtillon sous Bagneux, Hauts-de-Seine, France) *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium on Transonic Configurations, Bad Harzburg, West Germany, June 13-15, 1978, Paper 78-067* 23 p 11 refs In French (ONERA TP No 1978 67)

Two relaxation methods are presented within the framework of a mathematical model involving the full potential equation for simulating transonic flows set in a uniform subsonic free stream without side slip. In the first method, the equation is quasi-linear, and is discretized with a Murman-Cole scheme. In the second method, the equation is written in conservation form, and is discretized using a centered scheme. Calculated pressure distributions for both methods are compared with experimental data obtained in the ONERA S2MA test facility D M W

A78-45227 Transonic potential flow computations by finite elements - Airfoil and wing analysis, airfoil optimization A Eberle (Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn, West Germany) *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium on Transonic Configurations, Bad Harzburg, West Germany, June 13-15, 1978, Paper 78-065* 92 p 12 refs (MBB-UF-1428 0)

The finite element approach has been applied to the calculation of flow fields with complex solid boundary geometries. Transonic analysis procedures are discussed with reference to plane flows (airfoils and cascades) and axisymmetric flows (bodies in wind tunnels and nozzle inlets). Design procedures are given for the elliptical continuation, the hyperbolic problem, and airfoil and cascade optimization for shockless flows S C S

A78-45228 # The design and aerodynamic characteristics of an 18% thick shock-free airfoil /NLR 7501/ J. A. van Egmond and D. Rozendal (Nationaal Lucht- en Ruimtevaartlaboratorium, Amsterdam, Netherlands) *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium on Transonic Configurations, Bad Harzburg, West Germany, June 13-15, 1978, Paper 26* p 7 refs (NLR-MP-78016-U)

A78-45230 # Aerodynamic design of thick, supercritical wings through the concept of equivalent subsonic pressure distribution J W Slooff (Nationaal Lucht- en Ruimtevaartlaboratorium

Amsterdam, Netherlands) and N Voogt (Fokker-VFW, Schiphol Airport, Netherlands) *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium on Transonic Configurations, Bad Harzburg, West Germany, June 13-15, 1978, Paper 25* p 8 refs (NLR-MP-78011-U)

A procedure for aerodynamic design of thick, transport type wings with supercritical, shock free flow is described. Computational capabilities for two and three-dimensional flow are integrated through a concept of equivalent subsonic pressure distribution (ESPD). A key feature is the construction of a suitable three-dimensional target ESPD on the basis of a two-dimensional transonic and subsonic flow computation and engineering insight. The wing geometry required to generate the target ESPD is determined by means of three-dimensional inverse subsonic flow computations. Application to a 20-deg swept wing of aspect ratio 8 is described P T H

A78-45231 # Design and wind tunnel testing of the supercritical wing with manoeuvre flaps for the Alpha Jet as experimental aircraft A M Constant (ONERA, Châtillon sous Bagneux, Hauts-de-Seine, France), B Haftmann (Vereinigte Flugtechnische Werke-Fokker GmbH, Bremen, West Germany), and D Welte (Dornier GmbH, Friedrichshafen, West Germany) *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium on Transonic Configurations, Bad Harzburg, West Germany, June 13-15, 1978, Paper 37* p

The main geometric and aerodynamic characteristics of the supercritical wing with maneuver flaps for the Alpha Jet as experimental aircraft are described and compared with those of the Alpha Jet. All data result from wind tunnel measurements. The wing design is only considered in detail if the revision of the first wing design leading to the definition of the final wing is concerned (Author)

A78-45232 # The calculation of transonic flow over three-dimensional swept wings using the exact potential equation C R Forsey and M P Carr (Aircraft Research Association, Ltd, Bedford, England) *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium on Transonic Configurations, Bad Harzburg, West Germany, June 13-15, 1978, Paper 16* p 10 refs Research supported by the Ministry of Defence (Procurement Executive)

Only inviscid flows are considered, although there is an obvious extension to viscous flows using the boundary layer concept. A major difficulty in solving a three dimensional problem is related to the derivation of a suitable computing mesh for the approximation of the differential equation. The conventional approach for obtaining a suitable computing mesh is based on a use of transformations. The use of such transformations increases the complexity of the differential equation to be solved. The problems can be avoided by employing the Transonic Small Perturbation (TSP) equation. However, because of the restricted range of application of the TSP equation and its inherent approximations, it is preferable to solve the full potential equation if a suitable mesh can be found together with acceptable computing times. A description is presented of a method which satisfies these requirements. The described method uses a three-dimensional extension of a technique employed by Garabedian and Korn (1972) for two dimensions G R

A78-45233 Development of low sweep, high aspect ratio wings designed for high Reynolds number J R Wedderspoon (British Aerospace, Weybridge, Surrey, England) *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium on Transonic Configurations, Bad Harzburg, West Germany, June 13-15, 1978, Paper 19* p

Project optimization studies show that for a 160 seat aircraft with design range of 1600 nautical miles, the minimum D O C is achieved with the relatively low sweep of 23 deg and an aspect ratio of 9.5. The development by B Ae Weybridge of an advanced wing to meet this specification is described. Transonic theory has been used in both the 2-D and 3-D design and some of the problems which arose are discussed (Author)

A78-45234 # Flow development on a supercritical wing A J Bocci and M P Carr (Aircraft Research Association, Ltd, Bedford, England) *Deutsche Gesellschaft für Luft- und Raumfahrt,*

Symposium on Transonic Configurations, Bad Harzburg, West Germany, June 13-15, 1978, Paper 23 p 6 refs

Methods of experimenting on model wings in order to gain insight into the aerodynamics of flow past devices such as slats and flaps and to obtain quantitative estimates of performance increments attainable through their use are described. Two models have been used. The first has a 13% thickness/chord conventional section with some leading-edge droop. The second has an advanced, relatively peaked section of 8.5% thickness/chord. Tests at sweep angles of 0 and 25 deg are mentioned. The advanced wing gave pressure distributions which typically feature supercritical recompressions ahead of the shock on the upper surface from high peak sections near the leading edge and large amounts of rear loading. On this wing, major three-dimensional effects occur which are qualitatively well predicted by theory. P T H

A78-45236 # A method for the calculation of 2D and 3D transonic interference flows K-D Klevenhufen, H Jakob, and H Struck (Vereinigte Flugtechnische Werke Fokker GmbH, Bremen, West Germany) *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium on Transonic Configurations, Bad Harzburg, West Germany, June 13-15, 1978, Paper 27 p 23 refs*

A system of body fitted coordinates is employed within the framework of a relaxation method with finite differences to solve the full differential equation for the compressible flow velocity potential. Second interferences such as transonic flow around airfoils with a slat are calculated to illustrate the method. Anticipated supersonic flow around the wing is eliminated for the sake of computer economy. Attention is given to the axial symmetric case, whereby the system coordinates are defined by rotation surfaces. D M W

A78-45237 The prediction of viscous effects on aerofoils in transonic flow R C Lock (Royal Aircraft Establishment, Farnborough, Hants, England) *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium on Transonic Configurations, Bad Harzburg, West Germany, June 13-15, 1978, Paper 19 p 5 refs*

The paper describes a method for predicting the effect of the boundary layer and wake on the pressure distribution and forces on an airfoil in transonic flow (subsonic free stream), particular care being taken in cases with shock waves to ensure that the shock pressure jump is approximated as well as possible within the assumption that the external flow is isentropic and irrotational. Comparisons with experiment are given for four airfoils, with thicknesses in the range 12%-16% chord, all with rear loading, and three of specifically 'supercritical' type. (Author)

A78-45238 # An extended vortex lattice method for the application on subsonic/transonic transport aircraft configurations J Loerke and B Kieckebusch (Messerschmitt Bolkow-Blöhm GmbH, Hamburg, West Germany) *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium on Transonic Configurations, Bad Harzburg, West Germany, June 13-15, 1978, Paper 78-071 27 p 7 refs*

The paper describes a design process for wing-fuselage sections of transonic aircraft which combines linear theory prediction with an extended vortex lattice method. The vortex lattice method is based on classical inviscid linear wing theory. At the wing-fuselage intersection there is a violation of the kinematic flow condition which is compensated for by an iteratively obtained proper distribution of sources and vortex strengths. Illustrative results of the method obtained during a design cycle for a new A 300 B 10 wing are given. P T H

A78-45239 # The supercritical wing - An evolution or a revolution E Obert (Fokker-VFW, Shiphol Airport, Netherlands) *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium on Transonic Configurations, Bad Harzburg, West Germany, June 13-15, 1978, Paper 25 p 32 refs*

The characteristics of the flow about the 'supercritical wing' airfoil section, as given in the patent description, are examined and compared to the flow about a 'conventional airfoil'. An investigation

is conducted to determine whether the development of the supercritical wing represents a revolutionary advance in airfoil section development. The investigation takes into account a study performed by Stack and Von Doenhoff (1932-1933) and other work conducted by German aerodynamicists during the time before the end of the Second World War. The early high-speed airfoil research work was continued after the war in the U.S., the UK, France, and Holland. After a review of the various reports it is concluded that the present advanced transonic airfoil is the product of a long evolutionary development. If there has been 'a revolutionary breakthrough' it has been in the field of computational fluid dynamics. G R

A78-45240 # Design and experimental verification of two supercritical airfoils G Redeker and R Müller (Deutsche Forschungs- und Versuchsanstalt für Luft und Raumfahrt, Institut für Aerodynamik, Braunschweig, West Germany) *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium on Transonic Configurations, Bad Harzburg, West Germany, June 13-15, 1978, Paper 78-075 10 p 8 refs*

The design and experimental verification of two supercritical airfoils are discussed. The geometry of the DFVLR-R2 and DFVLR-R4 airfoils is shown and the equations used for design calculations are identified. Experimental investigations, carried out in a transonic wind tunnel, assessed (1) the aerodynamic forces and moments, (2) the development of the pressure distributions, (3) the drag-rise boundaries, and (4) the aerodynamic efficiency. It is concluded that the DFVLR R4 model yields better aerodynamic behavior. S C S

A78-45242 # The DFVLR Transonic Wind Tunnel Braunschweig - Wall interference corrections for the modified test section and results for the supercritical airfoil CAST 7 E Stanewsky, H Koster, W Puffert, and R Müller (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Strömungsmechanik, Göttingen, Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Aerodynamik, Braunschweig, West Germany) *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium on Transonic Configurations, Bad Harzburg, West Germany, June 13-15, 1978, Paper 45 p 19 refs*

The present contribution briefly describes the Transonic Wind Tunnel Braunschweig and presents results of an investigation to determine and reduce wind tunnel wall effects. Data obtained with the supercritical airfoil CAST 7 in this tunnel are compared to corresponding data from other wind tunnels. The sensitivity of the airfoil CAST 7 to Reynolds number effects is demonstrated up to Re of about 14,000,000. (Author)

A78-45243 An experimental investigation of the drag of thick supercritical aerofoils - A progress report P R Ashill and D J Weeks (Royal Aircraft Establishment, Farnborough, Hants, England) *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium on Transonic Configurations, Bad Harzburg, West Germany, June 13-15, 1978, Paper 20 p 14 refs*

There are good reasons for questioning the estimates of the drag of 'advanced' airfoils given by current methods for solving transonic, viscous flows. An investigation has, therefore, been conducted with the main objective of examining the sources of drag of thick supercritical airfoils having relatively large rear loading. Six airfoils have been designed for this purpose, each of 14% thickness but of differing degrees of rear camber and trailing edge thickness. Three of the airfoils have aerodynamically sharp trailing edges while the other three have been made with the dual aim of examining, first, the possibility of using trailing-edge thickness as a means of simulating, at wind tunnel scale, flows at high Reynolds number and second the effect of trailing-edge thickness on drag. A description is presented of the design and construction of the airfoil sections, the wake survey technique for measuring drag, and the methods used to reduce the data. G R

A78-45276 # Operational two-dimensional laser velocimeter for various wind tunnel measurements A Boutier, J Lefèvre, C Perouze, and O Papirnik (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France) (*Réunion de Travail Internationale sur la Vélocimétrie Laser*, 3rd, West Lafayette, Ind, July 11-13, 1978) ONERA, TP no 1978 74, 1978 12 p

A two-dimensional, two color fringe laser velocimeter has been designed for wind-tunnel experiments. The light source is an argon laser with 6 W of power on both the green (514.5 nm) and blue (488 nm) lines. Each laser beam passes through a separating system including a beam splitter and acousto-optic modulators. Beam deviations at the output are compensated by prisms. The receiving optics collect light at a distance in the 300 mm to 2 m range. The optical and mechanical configurations are mounted on a support which moves the probe volume along three rectangular axes with a translation amplitude of 200 mm. Signals are processed by counting techniques. Measurement accuracy is limited by particle behavior, the signal processor (1 percent), and the measurement of the fringe spacing (0.1-0.3 percent) SCS

A78-45277 # Results of laser synchronization by overflight between Paris and San Fernando in Spain (Resultats de la synchronisation laser par survol entre les observatoires de Paris et de San Fernando en Espagne) J Besson, H Brejard, J-P Moreau (ONERA, Châtillon sous Bagneux, Hauts-de-Seine, France), P Parcelier (Paris, Observatoire, Paris, France), and J Benavente (San Fernando, Observatorio, Cadiz, Spain) (*Conférence sur les Mesures Electromagnétiques de Précision*, Ottawa, Canada, June 26-29, 1978) ONERA, TP no 1978-40, 1978 4 p. In French

An experiment to measure the differences between the cesium clocks of the Paris and San Fernando observatories is described. The technique used was developed by ONERA. The method involves the emission of a laser beam at a set time in accordance with a ground-based clock. The beam reaches the aircraft transporting the cesium clock which is set according to the time scale of the other observatory, the beam stops the clock and is also reflected back to earth, so the distance and the time traveled by the beam can be calculated. The results show that a resolution of better than one nanosecond can be obtained, and that the time scales of the two observatories can be made identical within 20 nanoseconds. ML

A78 45280 .1 Determination of nonlinearities of dynamic stability (Détermination de non linearités de stabilité dynamique) X Vaucheret (ONERA, Châtillon sous Bagneux, Hauts-de-Seine, France) (*NATO, AGARD, Reunion sur les Parametres de Stabilité Dynamique*, Athens, Greece, May 22-24, 1978) ONERA, TP no 1978 52, 1978 15 p. 12 refs. In French

The use of the free oscillation method to investigate nonlinearities in the dynamic stability of models in wind tunnel studies is considered, and nonlinearities are classified on the basis of their effects, as interpreted by classical theories of nonlinear mechanics. Curvature and discontinuity nonlinearities are analyzed, and the resulting concepts are applied to a discussion of nonlinearities which lead to limit cycles. Nonlinearities associated with wind tunnel studies are examined, and heteronomous equations are derived. Equations for describing nonlinearities are obtained by determining the frequency and damping amplitude dependence during a transitory event. ML

A78 45282 A comparison of the performances of centrifugal compressors with the same impeller and different radial inducers (Comparaison des performances de compresseurs centrifuges de même avant roue et à roues radiales différentes) P Avram (ONERA, Châtillon sous-Bagneux, Hauts-de-Seine, France) ONERA, TP no 1978 42, 1978 15 p. In French

Attention is given to optimization of length and weight in consideration of three centrifugal rotors with the same impeller and diffuser, but differing from one another in the axial dimensions of the radial part of the rotor, i.e., short, medium, and long. Tests are conducted with Freon 114 in a closed circuit. It is found that sonic blockage of the impeller is the main cause of compression loss, and

that improvements can best be effected through modification of the inducer. DMW

A78-45341 Estimated temperature corrections for the Menaka-II meteorological rocket payload K G Vernekar and B Mohan (Indian Institute of Tropical Meteorology, Poona, India) (*Space Sciences Symposium, Trivandrum, India, Jan 18-21, 1977*) *Indian Journal of Radio and Space Physics*, vol 6, Dec 1977, p 281-284

The Menaka-II is a meteorological payload which has been developed to measure temperature and wind from 70-30 km. Correction procedures have been proposed to account for thermistor inertia, thermistor mounting position, parachute descent rate, and the effects of solar radiation. The application of a mylar film has been suggested to correct for the aerodynamic heating and conduction along lead wires. Nighttime measurements eliminate the influence of solar radiation. The temperature correction varies from 10-15°C at 80 km to 0-3°C at the ground. SCS

A78-45393 Distortion of the sonic boom pressure signature by high speed jets S L V Hall (New South Wales Institute of Technology, Broadway, Australia) *Acoustical Society of America, Journal*, vol 63, June 1978, p 1749-1752. 13 refs. Research supported by the Department of Transport of Australia.

Mach 2.5 (0.30 caliber) projectiles were used to simulate supersonic aircraft, the acoustic impedance mismatch was provided by either of two rectangular nozzles having exit Mach numbers of 1.00 and 1.82 when delivering correctly expanded helium jets. These nozzles were operated from 40% to 150% expansion at a fixed position relative to the pressure transducer when the projectile miss distance was 36 or 108 body diameters from the transducer. Schlieren optical photographs demonstrated that the bow shock was always folded or 'wrinkled' after passing through either of the jets. As exit Mach number decreased, the size of the shock front folds, as well as the divergent jet spread angle, increase and the bow shock becomes increasingly bent forward by the jet. Pressure signatures measured with a jet operating started 40-80 microsec earlier than those measured without a jet. All pressure signatures obtained with a jet operating exhibited similar varieties of waveforms as F 104, B 58, XB-70, SR 71, and Concorde OÖ2 flight test results. The wide variations in overpressure, rise time, duration, and wave shape are attributed to the velocity and density fluctuations of the turbulent jets. (Author)

A78-45394 * Multitube turbojet noise-suppression studies using cross-correlation techniques D R Regan and W C Meecham (California, University, Los Angeles, Calif) *Acoustical Society of America, Journal*, vol 63, June 1978, p 1753-1767. 35 refs. NASA supported research.

The noise generating region of a suppressed turbojet exhaust is studied by cross-correlating static pressure fluctuations within the exhaust with far-field sound for Mach numbers up to 0.99, using a 31-tube nozzle having an area ratio of 3.1. Measurements made with an unsuppressed turbojet exhaust having an equivalent area ratio and operating under effectively equal thrust loads serve as the experimental control. Static pressure level measurements, made with a calibrated high-temperature acoustically damped probe tube, show that noise suppression by multitube nozzles results from reduced turbulence levels. The maximum fluctuating static-pressure level in the unsuppressed turbojet exhaust is typically 5.6 dB higher than static pressure levels in the suppressed exhaust under conditions of effectively equal static thrust. This suggests that the turbulence intensity in the multitube suppressor flow is reduced in excess of 20% compared with the unsuppressed jet exhaust. BJ

A78-45410 Computer aided design of aircraft electrical systems B Dror, S Isaac, and W Eric (Israel Aircraft Industries, Ltd, Lod Airport, Israel) (*Annual Israel Conference on Aviation and Astronautics*, 19th, Tel Aviv, Israel, Mar 2-3, 1977) *Computers and Graphics*, vol 3, no 1, 1978, p 35-42. 5 refs.

The CAESAR interactive computer graphics system for the design, analysis and production of aircraft electrical circuitry is

described. The system is built up of several independent design, analysis and drafting modules which may be interactively interfaced in conjunction with an on line master data base. Preliminary cost-effectiveness predictions at IAI have shown that implementation of the total system in a production environment will introduce greater design efficiency relative to conventional methods, in addition to significant savings in time, effort and cost. (Author)

A78-45425 Aircraft flying performance Principles, flight attitude, flight phases (Flugleistungen Grundlagen, Flugzustände, Flugabschnitte) G Bruning (München, Technische Hochschule, Munich, West Germany) and X Hafer (Darmstadt, Technische Hochschule, Darmstadt, West Germany) Berlin, Springer Verlag, 1978 301 p 24 refs In German \$29 50

Basic information for an evaluation of aircraft flying performance is discussed, taking into account important physical constants, aircraft data, the characteristics of the atmosphere, aerodynamical forces, forces for aircraft propulsion, and basic flight equations. Attention is given to the general flight attitude equation, gliding conditions, horizontal flight, climbing, acceleration, flattening, curvilinear flight, and altitude-Mach number diagrams. The various phases of a flight mission considered include long distance flight, accelerating flight, ascent, curving operations, takeoff, and landing. Questions of flight optimization are considered along with the determination of the maximum flight range, aspects of maximum flight duration, lowest fuel consumption, and minimum flight costs. G R

A78-45429 * Reduction of aircraft gas turbine engine pollutant emissions - A status report L A Diehl (NASA, Lewis Research Center, Cleveland, Ohio) *Air Pollution Control Association, Annual Meeting, 71st, Houston, Tex., June 26-30, 1978, Paper 14* p 8 refs

In mid 1971, NASA began a major program in emission reduction technology, which would consist of a continuing in house effort on low emission combustor concepts and of contracted research programs with the major aircraft engine manufacturers. A description is presented of the design approaches taken by the manufacturers involved in the contracted programs. Current results are compared with EPA standards, and some of the engine related factors are briefly considered. In addition, some results from fundamental technology programs which indicate the emission levels which may be approached by advanced low emission combustors of the future are also discussed. It is found that special engine design features represent at least a partial solution to reducing aircraft emissions for engines of the future. G R

A78-45439 * VALT parameter identification flight test R L Tomaine (U S Army, Structures Laboratory, Hampton, Va.), W H Bryant, and W F Hodge (NASA, Langley Research Center, Hampton, Va.) *Associazione Italiana di Aeronautica ed Astronautica and Associazione Aerospaziali, European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, Sept 13-15, 1978, Paper 16* p 9 refs

The paper describes a method of establishing the accuracy of previously developed analytical models of research vehicles for a program for developing avionics technology for VTOL aircraft. The research vehicle is a Boeing Vertol CH-47 tandem rotor transport helicopter equipped with a fly-by-wire control system. The special sized flight test was designed to take into account the presence of winds at flight conditions from hover through transition to cruise. The test provided data to obtain estimates of derivatives by parameter identification. P T H

A78-45475 * The relative fire resistance of select thermoplastic materials D A Kourtides and J A Parker (NASA, Ames Research Center, Moffett Field, Calif.) *Plastic Design and Processing*, Apr 1978 11 p 11 refs

The relative thermal stability, flammability, and related thermochemical properties of some thermoplastic materials currently used in aircraft interiors as well as of some candidate thermoplastics were

investigated. Currently used materials that were evaluated include acrylonitrile butadiene styrene, bisphenol A polycarbonate, polyphenylene oxide, and polyvinyl fluoride. Candidate thermoplastic materials evaluated include 9,9 bis(4-hydroxyphenyl)fluorene polycarbonate poly(dimethylsiloxane) block polymer, chlorinated polyvinylchloride homopolymer, phenolphthalein polycarbonate, polyethersulfone, polyphenylene sulfide, polyarylsulfone, and polyvinylidene fluoride. M L

A78-45926 Avionics first principles IV Automatic flight control M Hirst *Flight International*, vol 114, Aug 5, 1978, p 411 414, 421

Various aspects of automatic flight control are discussed, noting autostabilizers and control-configured vehicles. The automatic lander computer is described and the development of procedures for all weather approaches are reviewed. Military systems are described with reference to terrain finding radar. S C S

A78-45937 Nondestructive testing of adhesive bonded structure D Hagemeyer and R Fassbender (McDonnell Douglas Corp., Huntington Beach, Calif.) *SAMPE Quarterly*, vol 9, July 1978, p 36 58 13 refs USAF sponsored research

An attempt is made to describe the state of the art of NDT as it pertains to adhesively bonded joints. Particular attention is given to the Primary Adhesively Bonded Structure Technology (PABST) program. The primary inspection instrument for PABST is the Fokker bondtester which is used to periodically evaluate damaged tolerance specimens and to inspect the bond joints during fabrication and later for periodic checks during the full scale structure tests. If the Douglas bonded fuselage concept goes into production, NDT would use automated X ray radiography or through-transmission ultrasonic C scan. The Fokker bondtester would be used for single bond joint lap-shear strength correlations to verify voids or porosity and to determine depth or bond line position of noted defects. B J

A78-46091 Supersonic flow over sharp-edged wings G P Voskresenskiy, A S Il'ina, and V S Tatarenchik (*PMTF - Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki*, Nov Dec 1977, p 35 42) *Journal of Applied Mechanics and Technical Physics* vol 18, no 6, May 1978, p 763 768 Translation

Solutions to numerical problems concerning the steady state, supersonic, inviscid flow past cusped wings are presented. A shock wave is attached to the wing's front edge. A boundary problem having initial data given by a finite-difference method to the second order of accuracy is solved. Flow characteristics at the freestream Mach number 3.0, and at various angles of incidence for triangular, sweptback, and rhombiform wings having different profiles are reviewed. It is shown that surface variations in the central, upper, and particularly lower wing surfaces are important factors to be considered in analyzing this type of flow. S C S

A78-46092 Calculation of interaction of a turbulent near-wake behind a step with a supersonic jet A N Antonov (*PMTF Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki*, Nov Dec 1977, p 43 51) *Journal of Applied Mechanics and Technical Physics*, vol 18, no 6, May 1978, p 769 774 14 refs Translation

An approximation method for calculating the interaction between a turbulent near wake behind a step and a supersonic flow is proposed. Calculations are also presented for the flow in the ground region of a truncated central body of an annular nozzle and the flow behind a one-dimensional step. S C S

A78-46105 Investigation of the residual fatigue life of material D16 ATV under two-step, low-cycle program loading A I Radchenko and A E Sultanov (Kievskii Institut Inzhenerov Grahzdanskoi Aviatsii, Kiev, Ukrainian SSR) (*Problemy Prochnosti*, Nov 1977, p 30-33) *Strength of Materials*, vol 9, no 11, July 1978, p 1312-1315 11 refs Translation

A78-46108 Statistical analysis and prediction of the heat-resistance characteristics of cast alloys for gas-turbine engine /GTD/ I P Bulygin, L N Timofeeva, E R Golubovskii, I P Trunin, R N Sizova, and I N Bogomolova (*Problemy Prochnosti*, Nov 1977, p 57-62) *Strength of Materials*, vol 9, no 11, July 1978, p 1337-1343 9 refs Translation

In the experiments described, specimens prepared from ZhS6U blade alloy were used to record the creep curve and to study the time to rupture at temperatures between 800 and 1050 C Particular attention was given to the dispersion of the strength characteristics and to the reliability of extrapolating to a given service life It is shown that with increasing time to rupture, dispersion first decreases and then increases, and that dispersion increases with increasing temperature V P

A78-46321 Experimental determination of a more powerful burn-in A Coppola (USAF, Rome Air Development Center, Griffiss AFB, NY) *IEEE Transactions on Reliability*, vol R 27, Aug 1978, p 181, 182

A method is described in which burn in is made more powerful by reducing the time spent in the high temperature extreme, thereby precipitating more failures for a given period The AN/ARC-164 transceiver for airborne communications is used as the subject of failure tests under conditions of both 2 hour nonoperating cold soak/2 hour operating heat soak, and 2 hour nonoperating cold soak/4 hour operating heat soak A Production Reliability Verification Test (PRVT) indicated that the results obtained by the two sequences are fully comparable D M W

A78-46354 The effects of nozzle geometry on the performance of an axisymmetric thrust augmentor G F Marsters and W Montasser (Queen's University, Kingston, Ontario, Canada) In *Heat Transfer and Fluid Mechanics Institute, Meeting, 26th, Pullman, Wash, June 26 28, 1978, Proceedings* Stanford, Calif, Stanford University Press, 1978, p 71 87 9 refs National Research Council of Canada Grant No A-4310

The effects of nozzle axial position, shape, and pressure ratio on the operation of an axisymmetric thrust augmentor are evaluated The study was statically conducted in the presence of a steady flow, both cross-shaped and round nozzles were used Thrust, mass flow, and pressure measurements were made for various axial positions of round nozzles The primary jet Mach number varied from 0.37 to 1.0 The nozzle Reynolds number varied from 38,000 to 800,000 Thrust augmentation was examined by the ratio of primary to secondary mass flow, wall static-pressure distributions, velocity profiles at the duct exit, and the center-line decay The study reveals that nozzle shape does not significantly influence thrust augmentation S C S

A78-46360 * The numerical solution of viscous flows at high Reynolds number R W MacCormack (NASA, Ames Research Center, Computational Fluid Dynamics Branch, Moffett Field, Calif) In *Heat Transfer and Fluid Mechanics Institute, Meeting, 26th, Pullman, Wash, June 26 28, 1978, Proceedings* Stanford, Calif, Stanford University Press, 1978, p 218-221 16 refs

A review is presented of implicit and hybrid methods applicable to solving viscous flows at high Reynolds numbers Flows within axisymmetric channels containing stationary shock waves, past blunt-nosed lifting airfoils, past sharp nosed symmetric airfoils with buffet, past three-dimensional compression ramps with side walls, and past ogive- and hemisphere cylinders at angle of attack have been examined Reynolds numbers as high as 10 to the 9th power have been used S C S

A78-46376 Photon correlation techniques for wind-tunnel anemometry J B Abbiss (Royal Aircraft Establishment, Farnborough, Hants, England) *IEEE Transactions on Aerospace and Electronic Systems*, vol AES 14, July 1978, p 546-557 28 refs

The experience gained at the Royal Aircraft Establishment in laser anemometry techniques, using a photon correlator, is reviewed

The theory of operation of the equipment is summarized for both laminar and turbulent flows, and methods of data-reduction are discussed, with particular reference to the optical criteria which should be met Flow seeding requirements are considered and a practical system described The results of a number of experiments on subsonic and supersonic airflows, both laminar and turbulent, are presented (Author)

A78-46377 A simplified instrument failure detection scheme R N Clark (Washington, University, Seattle, Wash) *IEEE Transactions on Aerospace and Electronic Systems*, vol AES 14, July 1978, p 558 563 8 refs

A simplified version of the dedicated observer scheme for detecting incipient instrument failures in automatic systems is presented This scheme requires only a single observer, driven by a single instrument Simple logical combinations of estimated instrument outputs from the observer with the actual instrument outputs allow small faults in all the instruments to be detected Tests on a simulation of a practical system indicate the scheme is robust with respect to a small uncertainty in a dynamic parameter of the controlled plant (Author)

A78-46494 Su-19 Fencer B Sweetman *Flight International*, vol 114, July 29, 1978, p 350-352

Available technical data on the Soviet swing-wing air to ground fighter, the Sukhoi Su-19 Fencer, are given Based on the one poor-quality photograph made available, a reconstruction of the planform and fairly reliable guesses at the front and side views are given Features of the aircraft include a fairly well inboard location of the wing pivots, large slab ailerons for roll control, side-by-side seating, and weaponry including the radio-guided short range AS 7 Kerry, anti-radar weapons, and a 40 km-range EO weapon known as Advanced TASM The power plants are conjectured to be two reheat turbofans with a dry thrust of 11,000 lb and reheat thrust of 18,000 lb Maximum speed at 36,000 ft is Mach 2+, long-range cruise at 36,000 ft is Mach 0.75 Most of the European central region can be attacked by the Fencer on a nonstop mission returning directly to Soviet bases P T H

A78-46502 # A critical look at V/STOL technology B W McCormick (Pennsylvania State University, University Park, Pa) *American Institute of Aeronautics and Astronautics, Conference on Air Transportation Technical Perspectives and Forecasts, Los Angeles, Calif, Aug 21 24, 1978, Paper 78 1526* 9 p 13 refs

A brief history of V/STOL since the middle 50's is presented along with a table which lists most of the different types of V/STOL vehicles The table indicates aircraft which have had a flight research program, those which have progressed to an operational evaluation prototype, and the one and only V/STOL aircraft which has become operational An attempt is made to evaluate the reasons for the comparatively poor results of the development work It is found that the aircraft which have been built and flown have been more costly and have offered appreciably less performance in the conventional mode than their CTOL counterparts However, it is argued that this technical reason has not been the overriding reason for the lack of V/STOL development It is thought that with today's technology the technical difficulties could be overcome It is recommended to select only two or three V/STOL configurations at the most for future development A decision should be made to develop these configurations to an operational status and the programs should be carried out to completion G R

A78-46503 * # A perspective of laminar flow control A L Braslow and R J Muraca (NASA, Langley Research Center, Hampton, Va) *American Institute of Aeronautics and Astronautics, Conference on Air Transportation Technical Perspectives and Forecasts, Los Angeles, Calif, Aug 21 24, 1978, Paper 78-1528* 40 p

A historical review of the development of laminar flow control technology is presented with reference to active laminar boundary-layer control through suction, the use of multiple suction slots, wind tunnel tests, continuous suction, and spanwise contamination

The ACEE laminar flow control program is outlined noting the development of three-dimensional boundary layer codes, cruise noise prediction techniques, airfoil development, and leading-edge region cleaning. Attention is given to glove flight tests and the fabrication and testing of wing box designs. C S S

A78-46511 # ATC system current and projected problems and recommended solutions - An airline pilot's view. R A Berube (National Airlines, Inc., Miami, Fla.) *American Institute of Aeronautics and Astronautics, Conference on Air Transportation Technical Perspectives and Forecasts, Los Angeles, Calif., Aug 21-24, 1978, Paper 78-1539* 11 p 80 refs

Current and projected ATC system capacity limitations are examined, taking into account high density terminal area congestion, resulting delays, and associated costs and increased collision risks. The reasons for the arising serious, costly, and unresolved capacity limitation problems are considered along with the approaches which can be used to solve them. Attention is given to ground based orientation, centralized control and the use of radar vectors, a DABS data link closed loop control, airport development problems, opinions that the runway is currently the limiting constraint, opinions that wake turbulence precludes reducing longitudinal separation, and the communication congestion. G R

A78-46514 * A historical overview of stall/spin characteristics of general aviation aircraft. S B Anderson (NASA, Ames Research Center, Moffett Field, Calif.) *American Institute of Aeronautics and Astronautics, Conference on Air Transportation Technical Perspectives and Forecasts, Los Angeles, Calif., Aug 21-24, 1978, Paper 78-1551* 10 p 19 refs

Even today, stall/spin accidents involving general aviation aircraft account for more fatal and serious injuries than any other kind of accident. The classic stall/spin accident is one in which the pilot stalls the aircraft at too low an altitude to affect recovery. The primary attention in the investigation is given to aerodynamic considerations, although it is recognized that human factors and pilot training are also very important aspects of the total problem. A review of some 70 years of flight indicates that incorporation of the proper combination of aerodynamic parameters to provide good stall/spin avoidance has persistently remained an elusive goal for designers of general aviation aircraft. G R

A78-46515 # Structural material trends in commercial aircraft. D T Lovell and M A Disotell (Boeing Commercial Airplane Co., Seattle, Wash.) *American Institute of Aeronautics and Astronautics, Conference on Air Transportation Technical Perspectives and Forecasts, Los Angeles, Calif., Aug 21-24, 1978, Paper 78-1552* 10 p

Future commercial aircraft developments leading to improved aircraft performance and economy will be partly based on an employment of more efficient structural materials. The employment of such materials will make it possible to reduce aircraft weight while maintaining safe, durable, and cost effective structures. The major structural materials used in today's commercial jet aircraft include aluminum (80%), steel (17%), and titanium (3%). The alloys are supplemented by fiber-reinforced plastics. Difficulties occurring in connection with the use of some of the materials are considered along with the approaches used to overcome these difficulties, taking into account corrosion problems with aluminum alloys, steels, and titanium alloys. Current new developments applicable to the next near-term generation of commercial jet aircraft are related to improved aluminum alloys, improved titanium alloys, graphite epoxy composites, and improved adhesive bonding systems. Materials systems for use in commercial jet aircraft structures in the late 1980s and beyond are also examined, giving attention to titanium alloys, aluminum ingot products, castings, aluminum powder metallurgy, hybrid structures, and composite structures. G R

A78-46526 Atmospheric Flight Mechanics Conference, Palo Alto, Calif., August 7-9, 1978, Technical Papers. Conference sponsored by the American Institute of Aeronautics and Astronautics.

New York, American Institute of Aeronautics and Astronautics, Inc., 1978. 350 p. Members, \$27, nonmembers, \$35.

Consideration is given to the identification of the stability parameters of an aeroelastic aircraft, C/STOL flight in wind disturbed by the presence of buildings, prediction of roll controllability of slender cruciform canard configurations, supersonic aerodynamic characteristics of a tail-control cruciform maneuverable missile with and without wings, and flying qualities of an aircraft with strongly indented nosetips. Papers are also presented on a technique for the assessment of fighter aircraft precision controllability, reentry vehicle dispersion from entry angular misalignment, entry dynamics performance predictions for Pioneer Venus probes, and a Monte Carlo analysis of the effect of uncertainties in hydrometeor profiles. B J

A78-46527 # Estimation of the aerodynamic stability and control parameters for the F-106A aircraft from flight data - Maneuver design and flight data analysis. B J Eulrich, K S Govindaraj (Calspan Corp., Buffalo, N.Y.), and W W Harrington (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). In *Atmospheric Flight Mechanics Conference, Palo Alto, Calif., August 7-9, 1978, Technical Papers*. New York, American Institute of Aeronautics and Astronautics, Inc., 1978, p 1-19. 15 refs. Contract No. F33615-73-C-3051 (AIAA 78-1326).

A78-46528 * Identification of the stability parameters of an aeroelastic airplane. E G Rynaski, D Andrisani, II, and N C Weingarten (Calspan Corp., Buffalo, N.Y.). In *Atmospheric Flight Mechanics Conference, Palo Alto, Calif., August 7-9, 1978, Technical Papers*. New York, American Institute of Aeronautics and Astronautics, Inc., 1978, p 20-27. 5 refs. NASA-supported research, Contract No. F33615-73-C-3051 (AIAA 78-1328).

Phase variable transformations are used to construct the mathematical model of an aeroelastic aircraft in a form that is amenable to partial or piecemeal acceptance of parameters estimated from flight data. The problem is one of parameter identification of large scale dynamic systems involving a system matrix characterized by about 200 elements. A mathematical model of the USAF Total In-Flight Simulator was computed using the FLEXSTAB program. As data became available during the progress of the flight test program, it was processed and substituted in the mathematical model for parameters obtained from the FLEXSTAB program. Results tend to show a progressive and orderly transition from an analytically defined mathematical model to one obtained from the flight tests of the actual aircraft. B J

A78-46530 * C/STOL flight in wind disturbed by the presence of buildings. W Frost, R Reddy, B Crosby (Tennessee, University, Space Institute, Tullahoma, Tenn.), and D W Camp (NASA, Marshall Space Flight Center, Space Science Laboratory, Huntsville, Ala.). In *Atmospheric Flight Mechanics Conference, Palo Alto, Calif., August 7-9, 1978, Technical Papers*. New York, American Institute of Aeronautics and Astronautics, Inc., 1978, p 34-39. 7 refs. (AIAA 78-1332).

This paper investigates the behavior of winds about block geometries characteristic of building shapes and of the flight performance of aircraft with characteristics of a DC-8 and a DHC-6 as they fly through the wind fields. The two dimensional equations of motion for the aircraft are written to include variable winds and wind shear components. The paper also presents a discussion of the influence of those terms in the equations of motion which explicitly contain effects due to wind shear. Also included is a study of the aircrafts' flight paths over the obstacles with both a fixed stick and an automatic landing system. (Author)

A78-46531 # Analysis of optimal turning maneuvers in the vertical plane. J Shinar (Technion - Israel Institute of Technology, Haifa, Israel), A Marari, D Blank, and E M Medinah. In *Atmospheric Flight Mechanics Conference, Palo Alto, Calif., August*

7-9, 1978, Technical Papers New York, American Institute of Aeronautics and Astronautics, Inc., 1978, p. 40-49 15 refs (AIAA 78-1333)

Maneuverability in the vertical plane has a great importance in performance assessment of high-thrust aircraft. In this paper two basic vertical turning maneuvers, the 'half loop' and the 'split-S' are analysed as examples. Optimality of these maneuvers is defined as 'minimum time' with specific energy considerations. The exact solution of the complete TPBVP, requires excessive computation, which is prohibitive for parametric analysis or real time airborne application. The paper concentrates on three topics: 1) investigation of singular thrust arcs, 2) overview and analysis of simple maneuver strategies, 3) approximate feed-back solution applying the method of singular perturbations. The analysis provides, without excessive computations, an insight for vertical maneuvering. (Author)

A78-46533 # **Dynamic stability of a helicopter carrying a suspended payload** B. L. Nagabhushan (Goodyear Aerospace Corp., Akron, Ohio). In Atmospheric Flight Mechanics Conference, Palo Alto, Calif., August 7-9, 1978, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1978, p. 61-72. 13 refs (AIAA 78-1335)

Dynamic stability of a helicopter carrying a simply suspended payload is systematically investigated using analytical models which describe the motion of such a configuration in varying complexity. Stability characteristics of the helicopter-load motion in forward flight, as predicted by these models, are examined to explain the consequences of dynamic coupling between the two bodies as well as to determine the adequacy of the simpler models for predicting instabilities. Results are presented which indicate that system instabilities in forward flight are primarily in the form of unstable, inherent oscillations of the helicopter and those induced by the suspended payload. Ratio of payload and helicopter masses, length of the suspension cable, location of the suspension point relative to vehicle mass center and forward speed are found to be important parameters which characteristically influence the stability of the system. (Author)

A78-46535 # **Prediction of roll-controllability of slender cruciform canard configurations** I. Gur, J. Shinar, and J. Rom (Technion - Israel Institute of Technology, Haifa, Israel). In Atmospheric Flight Mechanics Conference, Palo Alto, Calif., August 7-9, 1978, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1978, p. 83-91. 12 refs (AIAA 78-1338)

Canard configurations, having modular flexibility, are attractive candidates for modern guided weaponry. Roll control of such configurations requires careful aerodynamic design. Elaborate computations are, however, prohibitive. The paper presents a simplified mathematical model predicting induced rolling moments of slender cruciform canard configurations with reasonable engineering accuracy. It is based on a classical vortex model improved by considering tail-body interference both on vortex trajectories and the roll influence function. Comparison to wind-tunnel data at $M = 2.25$ for small angles of attack was satisfactory. The method can be extended for higher angles of attack and to include computation of induced forces and lateral moments. (Author)

A78-46536 * .. **Side-force alleviation on slender, pointed forebodies at high angles of attack** D. M. Rao (Old Dominion University, Research Foundation, Norfolk, Va.). In Atmospheric Flight Mechanics Conference, Palo Alto, Calif., August 7-9, 1978, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1978, p. 92-99. 5 refs. Grant No. NsG-1315 (AIAA 78-1339)

A new approach of alleviating high angle-of-attack side force on slender, pointed forebodies comprising a symmetrical pair of helical separation trips to disrupt the lee side vortices, has been demonstrated. Subsonic wind tunnel measurements on two axis-symmetric pointed bodies, a fuselage of non-circular cross-section and a

wing-fuselage combination, at angles of attack up to 56 degrees are presented. Also included are water tunnel flow visualization results portraying the action of helical trips in rapidly diffusing the leeward vortices and preventing vortex-wake asymmetry. (Author)

A78-46537 * # **Methods for calculating the transonic boundary layer separation for V/STOL inlets at high incidence angles** D. C. Chou, H. C. Lee (Iowa, University, Iowa City, Iowa), R. W. Luidens, and N. O. Stockman (NASA, Lewis Research Center, Cleveland, Ohio). In Atmospheric Flight Mechanics Conference, Palo Alto, Calif., August 7-9, 1978, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1978, p. 100-106. 10 refs. Grant No. NsG-3117 (AIAA 78-1340)

A semi-empirical scheme for the prediction of transonic pressure distribution on the surface of V/STOL inlets at high incidence angles has been developed. The investigation is intended to improve the boundary layer calculation and separation prediction by including the effects of shock wave-boundary layer interaction into the Lewis Inlet Viscous Computer Program. Wind tunnel results and theoretical pressure calculation for critical cases are used in constructing the transonic pressure distribution. The program, which describes the development of the boundary layer and predicts the possible flow separation, can handle the cases of inlets at high incidence angles where local supersonic region may occur in the flow. (Author)

A78-46539 * . **Maximum likelihood estimation of translational acceleration derivatives from flight data** R. E. Maine and K. W. Iliff (NASA, Flight Research Center, Edwards, Calif.). In Atmospheric Flight Mechanics Conference, Palo Alto, Calif., August 7-9, 1978, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1978, p. 121-131. 17 refs (AIAA 78-1342)

This paper shows that translational acceleration derivatives, such as pitching moment due to rate of change of angle of attack, can be estimated from flight data with the use of appropriately designed maneuvers. No new development of estimation methodology is necessary to analyze these maneuvers. Flight data from a T-37B airplane were used to verify that rate of change of angle of attack could be estimated from rolling maneuvers. (Author)

A78-46540 * # **The influence of unsteady aerodynamics on extracted aircraft parameters** M. J. Queijo (NASA, Langley Research Center, Hampton, Va.), W. R. Wells (Wright State University, Dayton, Ohio), and D. A. Kesar (Cincinnati, University, Cincinnati, Ohio). In Atmospheric Flight Mechanics Conference, Palo Alto, Calif., August 7-9, 1978, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1978, p. 132-139. 7 refs (AIAA 78-1343)

The effect of accounting for unsteady aerodynamics on the parameters extracted from flight data is examined. Longitudinal equations of motion have been modified, and a parameter extraction program developed to include the effects of unsteady aerodynamics. The approach used was to generate pseudo data using the unsteady aerodynamics model and to use that data in two parameter extraction programs, one including and the other neglecting unsteady effects to see if the parameters were significantly different. Flight data for a light airplane also was used with the two extraction programs for the same purpose. Results showed that, for the cases considered, including unsteady aerodynamics in the parameter extraction program did affect the extracted quantities, particularly the damping in pitch. In addition, the parameter variances were lower when unsteady aerodynamics were included in the extraction program than when the effects were neglected. (Author)

A78-46541 * # **Aircraft parameter estimation in frequency domain** V. Klein (George Washington University, Joint Institute for Acoustics and Flight Sciences, Hampton, Va.). In Atmospheric Flight Mechanics Conference, Palo Alto, Calif., August 7-9, 1978, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1978, p. 140-147. 16 refs. Grant No. NsG-1161 (AIAA 78-1344)

The algorithms for the equation error and output error methods, the two basic procedures for the extraction of aircraft parameters

from flight data, are formulated in the frequency domain. The output error method includes the maximum likelihood estimation technique. This is further extended to those cases where the measured data is in the form of frequency response curves and the model of an aircraft includes elastic degrees of freedom and unsteady aerodynamics. Then the generalized maximum likelihood method, which can be applied to the identification of an aircraft subjected to external disturbances, is introduced. Next, all estimation methods mentioned are discussed with emphasis on advantages of the frequency domain analysis. The paper concludes with an example using real flight data. (Author)

A78-46550 * / Flying qualities of an aircraft with strong lateral-directional coupling. R. F. Stengel and G. E. Miller (Princeton University, Princeton, N.J.) In Atmospheric Flight Mechanics Conference, Palo Alto, Calif., August 7-9, 1978, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1978, p. 225-237. 18 refs. Contract No. NAS1-13502 (AIAA 78-1361)

Flying qualities of aircraft with strong lateral-directional coupling may be unsatisfactory without command and stability augmentation. Although sensitivity to stability derivative variation may be decreased by such a flight control system (FCS), deficiencies associated with control derivative uncertainty may persist or worsen. This is especially true in systems with necessarily high gains, e.g., the Space Shuttle Entry FCS. Effects of stability/control derivative variations on the flying qualities of the Space Shuttle (with and without FCS) have been investigated, and the unaugmented Space Shuttle has been simulated in flight using Princeton's Variable Response Research Aircraft (VRA). (Author)

A78-46551 # Simulator studies of powered-lift aircraft handling qualities in the presence of naturally occurring and computer-generated atmospheric disturbances. W. F. Jewell, R. K. Heffley, W. F. Clement (Systems Technology, Inc., Mountain View, Calif.), and T. C. West (FAA, Washington, D.C.) In Atmospheric Flight Mechanics Conference, Palo Alto, Calif., August 7-9, 1978, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1978, p. 238-242. 8 refs. U.S. Department of Transportation Contract No. FA77WA 3936 (AIAA 78-1362)

Selected results are presented from a two-phased experimental program to investigate powered-lift aircraft handling quality degradation due to both naturally occurring and computer-generated atmospheric turbulence. In Phase I, a variable stability helicopter was flown to simulate a powered lift aircraft on final approach. In Phase II, a ground-based simulator with a moving cockpit and a colored visual display was used to represent the same powered lift aircraft. During Phase II, a Dryden model of atmospheric turbulence was used as well as actual wind profiles recorded during Phase I. This paper focuses on the Phase II results, which demonstrate that the naturally occurring atmospheric turbulence yields handling quality ratings and pilot vehicle performance inferior to those obtained with the Dryden model. (Author)

A78-46552 # An experimental investigation of control-display requirements for a jet-lift VTOL aircraft in the terminal area. J. V. Lebacqz and R. C. Radford (Calspan Corp., Buffalo, N.Y.) In Atmospheric Flight Mechanics Conference, Palo Alto, Calif., August 7-9, 1978, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1978, p. 243-252. 17 refs. Contract No. N62269 76-C-0370 (AIAA 78-1363)

A flight experiment using the U.S. Navy X-22A V/STOL aircraft was conducted to examine control system and display presentation requirements for a jet-lift VTOL aircraft performing decelerating approaches under instrument flight conditions. Aerodynamic characteristics of the McDonnell Douglas AV-8B Advanced Harrier were simulated for a prescribed decelerating approach profile using the X-22A's variable stability system. Around this simulation, an analog of the AV-8B control system was implemented to investigate a range of realizable control system designs. Combinations of these control

concepts and a variety of head-up display formats and information levels were evaluated in flight for simulated instrument approaches. (Author)

A78-46553 * # A technique for the assessment of fighter aircraft precision controllability. T. R. Sisk (NASA, Flight Research Center, Aerodynamic Stability and Control Branch, Edwards, Calif.) In Atmospheric Flight Mechanics Conference, Palo Alto, Calif., August 7-9, 1978, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1978, p. 253-265. 8 refs. (AIAA 78-1364)

Today's emerging fighter aircraft are maneuvering as well at normal accelerations of 7 to 8 g's as their predecessors did at 4 to 5 g's. This improved maneuvering capability has significantly expanded their operating envelope and made the task of evaluating handling qualities more difficult. This paper describes a technique for assessing the precision controllability of highly maneuverable aircraft, a technique that was developed to evaluate the effects of buffet intensity on gunsight tracking capability and found to be a useful tool for the general assessment of fighter aircraft handling qualities. It has also demonstrated its usefulness for evaluating configuration and advanced flight control system refinements. This technique is believed to have application to future aircraft dynamics and pilot vehicle interface studies. (Author)

A78-46554 * # Effects of dynamic aeroelasticity on handling qualities and pilot rating. R. L. Swaim (Purdue University, West Lafayette, Ind.) and W. Y. Yen. In Atmospheric Flight Mechanics Conference, Palo Alto, Calif., August 7-9, 1978, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1978, p. 266-271. 10 refs. Grant No. N5G 4003 (AIAA 78-1365)

Pilot performance parameters, such as pilot ratings, tracking errors, and pilot comments, were recorded and analyzed for a longitudinal pitch tracking task on a large, flexible aircraft. The tracking task was programmed on a fixed base simulator with a CRT attitude director display of pitch angle command, pitch angle, and pitch angle error. Parametric variations in the undamped natural frequencies of the two lowest frequency symmetric elastic modes were made to induce varying degrees of rigid body and elastic mode interaction. The results indicate that such mode interaction can drastically affect the handling qualities and pilot ratings of the task. (Author)

A78-46558 * / Modeling and parameter uncertainties for aircraft flight control system design. W. W. Rickard (McDonnell Douglas Corp., Long Beach, Calif.) In Atmospheric Flight Mechanics Conference, Palo Alto, Calif., August 7-9, 1978, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1978, p. 294-303. 10 refs. Contract No. NAS1-14151 (AIAA 78-1371)

As aircraft designs trend toward further applications of control-configured vehicle concepts, aircraft control systems increasingly rely on stability augmentation to obtain normal flying qualities and reasonable structural margins. Although the control system designer would choose to have a perfect dynamic description of the vehicle, he knows that a level of uncertainty of plant dynamics will exist. This paper gives typical values of plant uncertainties for some recent aircraft design and development programs. Histories of pertinent aerodynamic, inertial, and structural parameters from program initiation to aircraft certification are given. These data can be used as typical of future vehicles so that control system design concepts can be evaluated with due consideration to their sensitivity to uncertainties in plant dynamics. (Author)

A78-46559 # Verification of fighter aircraft command augmentation control laws by nonlinear simulation. P. W. Berry and J. R. Broussard (Analytic Sciences Corp., Reading, Mass.) In Atmospheric Flight Mechanics Conference, Palo Alto, Calif., August 7-9, 1978, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1978, p. 304-312. 9 refs. Contract No. N00014 75-C-0932 (AIAA 78-1372)

A digital flight control system (DFCS) for a highly maneuverable fighter aircraft is described and evaluated in this paper. The aircraft and DFCS exhibit uniform handling qualities over the entire velocity angle of attack-roll rate regime encountered in air combat maneuvering (ACM). This is verified by the use of a nonlinear six-degree-of-freedom aircraft simulation and an ACM pilot model. Comparison of the tracking accuracy of the DFCS aircraft to that of a conventionally controlled aircraft indicates that the DFCS provides better tracking and reduces the likelihood of control-induced departure. (Author)

A78-46560 * # Flight tests of a simple airborne device for predicting clear air turbulence encounters. R. L. Kurkowski, C. E. Duller, III (NASA, Ames Research Center, Moffett Field, Calif.), and P. M. Kuhn (NOAA, Environmental Research Laboratories, Boulder, Colo.) In: Atmospheric Flight Mechanics Conference, Palo Alto, Calif., August 7-9, 1978, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1978, p. 320-324. 6 refs. (AIAA 78-1375)

An airborne clear air turbulence detector is being flight-tested on board NASA's C-141 and Learjet aircraft. The device is an infrared (IR) sensor in the water vapor band and is designed to detect changes in vapor concentrations associated with turbulence in shear conditions. Warnings of about 5 min have been demonstrated at flight altitudes from 9.1 to 13.7 km (30,000 to 45,000 ft). Encounter predictions were obtained 80% of the time, and false alarms were given about 6% of the time. Several simple algorithms were studied for use as signal output analyzers and for alert triggering. (Author)

A78-46561 # Correlation of experimental and theoretical steady-state spinning motion for a current fighter airplane using rotation-balance aerodynamic data. T. F. Langham (ARO, Inc., Arnold Air Force Station, Tenn.) In: Atmospheric Flight Mechanics Conference, Palo Alto, Calif., August 7-9, 1978, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1978, p. 325-336. 17 refs. (AIAA 78-1373)

An analytical study has been conducted to determine the usefulness of rotation-balance aerodynamic data in calculating the steady state spin motion of a current fighter aircraft configuration. The analysis utilizes a nonlinear six-degree-of-freedom digital computer program. Simulated spins are generated utilizing (1) static and forced-oscillation data, and (2) static, forced-oscillation, and rotation balance aerodynamic data. A method was devised by which these aerodynamic force and moment data could be combined to evaluate the inclusion of rotation balance data. The motions produced by including the rotation-balance aerodynamic data more closely simulate the motions exhibited during the flight tests. (Author)

A78-46563 # Nonlinear dynamic-aerodynamic interaction. D. F. Thrasher, D. T. Mook, and A. H. Nayfeh (Virginia Polytechnic Institute and State University, Blacksburg, Va.) In: Atmospheric Flight Mechanics Conference, Palo Alto, Calif., August 7-9, 1978, Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1978, p. 343-346. 10 refs. Grant No. DAAG29-76 G-0034. (AIAA 78-1346)

The nonlinear unsteady vortex-lattice technique in conjunction with a predictor-corrector method is used to calculate the dynamic response of a thin three-dimensional wing moving through an incompressible fluid. The problem is posed in terms of a moving reference frame attached to the wing. With the present technique, there are no restrictions on the planform, angle of attack or aspect ratio as long as separation occurs along sharp edges only and vortex bursting does not occur. The flow field, loads and motion of the wing are predicted simultaneously. The loads exhibit hysteretic behavior during cyclic motion and aerodynamic damping is observed. (Author)

A78-46565 # Piloting and control systems for airplanes and helicopters (Pilotazhnye komplekсы i sistemy upravleniya samoletov i vertoletov). V. T. Borodin and G. I. Ryl'skii. Moscow: Izdatel'stvo Mashinostroenie, 1978. 216 p. 122 refs. In Russian.

Aircraft piloting and control systems including both manual and automatic control and information display systems are described in this book. The discussion specifically concerns non-Soviet systems. The ergonomic aspects of pilot system design are investigated. Mechanical and electric systems of stick control for airplanes are considered. The automatic control systems of various light and heavy airplanes, helicopters, and VTOL aircraft are studied. P. T. H.

A78-46583 # Combustion in flow (Gorenie v potoke). A. V. Talantov. Moscow: Izdatel'stvo Mashinostroenie, 1978. 160 p. 35 refs. In Russian.

The physical foundations of the theory of combustion in a gas flow as applied to processes in aircraft combustion chambers are set forth. Central attention is focused on combustion in turbulent flow. Problems of flame stabilization and calculation of the flame position in ramjet engines are studied. Questions of similarity are considered, and the problem of transferring laboratory results on model burners to real chambers is investigated. P. T. H.

A78-46588 Construction of airfoil profiles approximating a given profile (Sur la construction de profils aerodynamiques voisins d'un profil donne). R. Laporte (Montpellier II, Universite, Montpellier, France). *Journal de Mecanique*, vol. 17, no. 2, 1978, p. 207-229. 20 refs. In French.

Some univalence criteria for meromorphic functions outside the unit circle are applied to the construction of airfoil profiles by conformal mapping. This permits obtaining families of profiles depending on a finite number of parameters. Finally, by iterating Hadamard's formula up to the second order, one obtains an approximate construction of profiles near to a given profile with nonzero thickness. (Author)

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STAR ENTRIES

N78-28043*# General Electric Co., Cincinnati, Ohio Aircraft Engine Group

ACOUSTIC TESTS OF DUCT-BURNING TURBOFAN JET NOISE SIMULATION Final Report

P R Knott, E J Stringas, J F Brausch, P S Staid, P H Heck and D Latham Jul 1978 345 p refs

(Contract NAS3-18008)

(NASA-CR-2966 DOC-R77AEG524) Avail NTIS HC A15/MF A01 CSCL 20A

The results of a static acoustic and aerodynamic performance model-scale test program on coannular unsuppressed and multielement fan suppressed nozzle configurations are summarized. The results of the static acoustic tests show a very beneficial interaction effect. When the measured noise levels were compared with the predicted noise levels of two independent but equivalent conical nozzle flow streams, noise reductions for the unsuppressed coannular nozzles were of the order of 10 PNdB, high levels of suppression (8 PNdB) were still maintained even when only a small amount of core stream flow was used. The multielement fan suppressed coannular nozzle tests showed 15 PNdB noise reductions and up to 18 PNdB noise reductions when a treated ejector was added. The static aerodynamic performance tests showed that the unsuppressed coannular plug nozzles obtained gross thrust coefficients of 0.972 with 1.2 to 1.7 percent lower levels for the multielement fan-suppressed coannular flow nozzles. For the first time anywhere, laser velocimeter velocity profile measurements were made on these types of nozzle configurations and with supersonic heated flow conditions. Measurements showed that a very rapid decay in the mean velocity occurs for the nozzle tested. J M S

N78-28047 European Space Agency Paris (France) NUMERICAL CALCULATION OF THREE-DIMENSIONAL UNSTEADY FLOWS WITH VORTEX SHEETS

Colmar Rehbach *In its* La Rech Aerospatiale Bi-monthly Bull No 1977-5 (ESA-TT-459) May 1978 p 48-66 refs Translated into ENGLISH from La Rech Aerospatiale Bull Bimestriel (Paris) no 1977-5 Sep-Oct 1977 p 289-298 Original report in FRENCH previously announced as A78-16620

Avail NTIS HC A06/MF A01

An important problem in the development of numerical methods for calculating three-dimensional high Reynolds number separated flows involves taking into account the vortex sheets generated by lifting obstacles in an incompressible flow with evanescent viscosity. Existing calculation methods approach this problem by means of surface distributions of horseshoe vortex or doublet type singularities. The approach proposed here is based on a volume discretization of the vortex vector which in three-dimensional flow will vary with time as a function of the local distortions of the velocity field in a manner consistent with the conservation theorems pertaining to vortex flows. The theoretical bases are reviewed and the Lagrangian integro-differential formulation is established so as to permit following the evolution in time of a discrete distribution of fluid particles each carrying a vortex vector. The numerical process is applied to the calculation of the sheet and the aerodynamic coefficients of a low-aspect-ratio rectangular flat plate. The case of instantaneous setting in motion is treated as is the case of a sinusoidal variation of angle of attack. Sheet formation occurs either at the trailing edge and along the wing tip or all around the wing edges. Author (ESA)

N78-28051# RAND Corp., Santa Monica, Calif THE MILITARY UTILITY OF VERY LARGE AIRPLANES AND ALTERNATIVE FUELS

William T Mikolowsky, Larry W Noggle and William L Stanley Sep 1977 29 p refs (AD-A053604 P-5994) Avail NTIS HC A03/MF A01 CSCL 01/3

The specific objectives of this work were: Evaluate very large airplanes (VLAs) in the context of existing and possible future Air Force missions and determine the most attractive alternative fuel for airplanes of this type. GRA

N78-28052*# National Aeronautics and Space Administration Langley Research Center Langley Station, Va

EFFECT OF CAMBER ON THE TRIMMED LIFT CAPABILITY OF A CLOSE-COUPLED CANARD-WING CONFIGURATION

Blair B Gloss Jul 1978 94 p refs

(NASA-TM-78686 L-12102) Avail NTIS HC A05/MF A01 CSCL 01A

A close-coupled canard-wing configuration was tested in the Langley high-speed 7 by 10 foot tunnel at a Mach number of 0.30 to determine the effect of changing wing camber on the trimmed lift capability. Trimmed lift coefficients of near 2.0 were attained, however, the data indicated that the highest buffet-free trimmed lift coefficient attainable was approximately 1.30. The buffet used in this investigation were qualitative in nature and gave no indication of buffet intensity. Thus, the trimmed lift coefficient of near 2.0 might be attainable if the buffet intensity was not too high. The data showed that there was approximately a 10 percent variation in drag coefficient for different model configurations at a given trimmed lift coefficient. Large increases in wing lift had only small effects on canard lift. Author

N78-28053*# National Aeronautics and Space Administration Ames Research Center Moffett Field, Calif

WING ANALYSIS USING A TRANSONIC POTENTIAL FLOW COMPUTATIONAL METHOD

P A Henne (McDonnell Douglas Corp Long Beach Calif) and R M Hicks Jul 1978 60 p refs

(NASA-TM-78464 A-7308) Avail NTIS HC A04/MF A01 CSCL 01A

The ability of the method to compute wing transonic performance was determined by comparing computed results with both experimental data and results computed by other theoretical procedures. Both pressure distributions and aerodynamic forces were evaluated. Comparisons indicated that the method is a significant improvement in transonic wing analysis capability. In particular, the computational method generally calculated the correct development of three-dimensional pressure distributions from subcritical to transonic conditions. Complicated multiple shocked flows observed experimentally were reproduced computationally. The ability to identify the effects of design modifications was demonstrated both in terms of pressure distributions and shock drag characteristics. G G

N78-28054*# Northrop Corp Hawthorne, Calif Aircraft Group

AERODYNAMIC CHARACTERISTICS OF A JET SHEET VORTEX GENERATOR

H Ziegler and P T Wooler Jun 1978 60 p refs

(Contract NAS1-14216)

(NASA-CR-158904, NOR-78-24) Avail NTIS HC A04/MF A01 CSCL 01A

A configuration concept for augmenting the lift capability of low aspect ratio thin wings, typically used on fighter aircraft was investigated. The fluid strike concept uses a jet sheet formed by blowing from a series of small orifices located in the side of the fuselage ahead of the wing to generate a stable vortex flow over the wing at high angle of attack. The effect of the location of the fluid strike relative to the wing was investigated for three different designs of the in-line orifices using a half-span model tested in a 7 by 10 foot low speed tunnel. Based on the results of the low speed test, a jet sheet producing module was incorporated into a NASA general research fighter model and tested in the Langley 7 by 10 foot high speed tunnel to determine the effectiveness of the fluid strike as a lift-enhancement device in the high-speed maneuver regime. Tests were conducted over

a Mach number range from 0.3 to 0.8 with a jet momentum coefficient range from 0 to 0.24. Significant lift increments resulted at the higher angles of attack and drag polars were improved.

ARH

N78-28056* National Aeronautics and Space Administration Langley Research Center Langley Station Va
AN ANALYSIS OF THE GUST-INDUCED OVERSPEED TRENDS OF HELICOPTER ROTORS

Julian L Jenkins Jr and William T Yeager Jr (AVRADCOM Res and Technol Labs) Jul 1978 23 p refs (NASA-TP-1213 AVRADCOM-TR-78-24 L-12159) Avail NTIS HC A02/MF A01 CSCL 01A

Equations for analyzing the potential gust-induced overspeed tendency of helicopter rotors are presented. A parametric analysis was also carried out to illustrate the sensitivity of rotor angular acceleration to changes in rotor lift propulsive force, tip speed and forward velocity.

GG

N78-28059 National Aerospace Lab Amsterdam (Netherlands) Scientific Services

DESIGN AND ANALYSIS OF A HODOGRAPH METHOD FOR THE CALCULATION OF SUPERCRITICAL SHOCK-FREE AEROFOILS Ph.D Thesis - Tech. Hogeschool Twente

J W Boerstoeel 14 Apr 1977 231 p refs (NLR-TR-77046-U) Avail NTIS HC A11/MF A01

An algorithm for the computational design of supercritical shock-free airfoils is developed and analyzed with hodograph theory. Such an algorithm may be based on the combination of two approaches for the construction of solutions of the flow equations for shock-free transonic flow. In this study an operational method developed by Lighthill Goldstein Craggs Mackie and Nieuwland is used though. The construction of analytic compressible flow solutions with the operational method selected is discussed. In order to enhance the efficiency of the calculations new choices were made for the structure of the compressible flow solution. New choices were also made for the normalizing functions depending on the free-stream Mach number of the flow. In order to obtain solutions without Tricomi singularities, the Tricomi boundary value problem is reformulated as an optimal control problem within a space of analytic solutions of the flow equation. Continuity of the airfoil (and its image on the hodograph surface) is obtained with a special error functional that controls the position of a free boundary curve. The approximate solution of the resulting optimal-control problem is discussed and analyzed in detail. Numerical results are presented which show that interesting airfoils are obtained and that the algorithm performs well.

Author (ESA)

N78-28061 Aeronautical Research Inst of Sweden Stockholm Aerodynamics Dept

CALCULATION OF LAMINAR BOUNDARY LAYERS ON INFINITE SWEEP WINGS BASED ON THWAITES TWO-DIMENSIONAL METHOD [BERAEKNING AV LAMINAERA GRAENSSKIKT PAA OAENDLIGA SVEPTA VINGAR UTGAARENDE FRAAN THWAITES TVAA-DIMENSIONELLA METOD]

A Bertelrud 1977 64 p refs In SWEDISH (Contracts F-INK-82223-75-007-07-001 F-INK-82223-76-001-21-001)

(FFA-AU-1431) Avail NTIS HC A04/MF A01

A computer program for incompressible laminar boundary layers on infinite swept wings is described. The program was developed to estimate Reynolds number effects for various front edge designs, give plausible initial values for turbulent computer programs, apply and fit various empirical correlations for stability, reversal, relieving etc. and give information on the thermal boundary layer (Smith and Spalding method). The program is an integral one based on Thwaites two-dimensional method in which the fundamentals for the equation were taken from literature. It is pointed out that the criteria used to define instability reversal etc. must be regarded only as an indication of probable current forms. In the presented version the program is incompressible.

Author (ESA)

N78-28062 Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt Brunswick (West Germany) Abt Entwurfsaerodynamik

NEW MODEL UPWIND DISTRIBUTIONS AND THEIR INFLUENCE ON THE DESIGN OF GLIDERS [NEUE MODELLAUFWINDVERTEILUNGEN UND IHR EINFLUSS AUF DIE AUSLEGUNG VON SEGELFLUGZEUGEN]

K-H Horstmann Dec 1976 30 p refs In GERMAN (DLR-B-151-76/12) Avail NTIS HC A03/MF A01

The upwash distribution according to Carmichael, used thus far for calculating the overland flight speed of gliders, was tested critically. Using upwind measurements and taking practical flight test experience into account, new model upwind distributions were defined and tested. For gliders of the open and of the standard class, the influence of the newly defined upwind distributions on the most important aircraft parameters was recorded.

ESA

N78-28064 European Space Agency, Paris (France)

STRUCTURAL MODIFICATIONS ON A SWEEP WING MODEL WITH TWO EXTERNAL STORES BY MEANS OF MODAL PERTURBATION AND MODAL CORRECTION METHODS

Raymond Freymann May 1978 48 p refs Transl into ENGLISH of Anwend u Vergleich modaler Perturbationsmethoden u modaler Korrekturverfahren am Beispiel eines Pfeilfluegels mit zwei Pylonaussenlasten DFVLR Goettingen West Ger Report DLR-FB-77-21 27 May 1977 Original report in GERMAN previously announced as N78-18014. Original German report available from DFVLR Cologne DM 22 60.

(ESA-TT-463 DLR-FB-77-21) Avail NTIS HC A03/MF A01

Investigations on swept wing model structure with two external stores were carried out by applying modal perturbation methods and modal correction procedures to inertia modifications on the external stores. Experimental modal data resulting from ground vibration tests on the same model structure in two different configurations were partially compared with calculated modal data in order to check the accuracy and suitability of the different modification methods.

ESA

N78-28065 Technische Hogeschool Delft (Netherlands) Dept of Aerospace Engineering

THE LIFTING WING WITH MINIMUM DRAG IN SUPERSONIC FLOW

H J Bos Oct 1977 58 p refs (VTH-LR-274) Avail NTIS HC A04/MF A01

An attempt was made to obtain some insight in a proper formulation of a drag minimization problem for thin wings in supersonic flow. If the planform is not fixed, the introduction of a few geometrical constraints is shown to be necessary. In analogy with slender body theory, an area of entrainment can be introduced. A planform with minimum drag is proved to be a planform with maximum area of entrainment. At the same time, some interesting features of the velocity field around an optimum wing and of the corresponding load distribution on the optimum wing are shown.

Author (ESA)

N78-28070 National Aviation Facilities Experimental Center, Atlantic City, N J

TRSB MICROWAVE LANDING SYSTEM DEMONSTRATION PROGRAM AT CAPE MAY, NEW JERSEY, USA Final Report, 27 Sep 1977 - 8 Oct 1977

Oct 1977 31 p (FAA Proj 075-725-700)

(AD-A054605, FAA-NA-78-13, FAA-RD-78-13) Avail NTIS HC A03/MF A01 CSCL 17/7

The small community (SC) time reference scanning beam (TRSB) microwave landing system was demonstrated at the Cape May County Airport. The SC system provides proportional guidance over an azimuth sector of + or - 10 degrees about the runway centerline with clearance signals out to + or - 40 degrees. Proportional guidance is provided in elevation from 2 degrees to 11 degrees. Flydown clearance is provided from 11 degrees to 15 degrees. System coverage is at least 20 nautical miles in heavy rain. Demonstration flights were conducted using a DC-6 and a Twin Otter. Data were collected utilizing a radio theodolite.

Results of these tests indicate some of the following (1) the system required minimal site preparation and installation time, (2) the system was subjectively determined to have very good guidance characteristics (3) the small community system exceeds its design specifications, and (4) the small community TRSB configuration path and course signal structure meets Category 2 ILS requirements B B

N78-28071# National Aviation Facilities Experimental Center, Atlantic City, N J
TRSB MICROWAVE LANDING SYSTEM DEMONSTRATION PROGRAM AT BUENOS AIRES, ARGENTINA Final Report, Oct - Nov 1977
 Nov 1977 38 p
 (FAA Proj 075-725-710)
 (AD-A054451, FAA-NA-78-14, FAA-RD-78-14) Avail NTIS HC A03/MF A01 CSCL 01/4

The basic narrow time reference scanning beam (TRSB) microwave landing system was collated with UHF/VHF ILS and at the Jorge Newbery Aeroparque. The system was designed for azimuth proportional guidance plus or minus 40 deg about the runway center line, elevation proportional guidance from 1 degree to 15 degrees, and converge of at least 20 nautical miles in heavy rain. Most of the flights were in the NASA B-737 terminal configured vehicle which recorded TRSB angle data, together with ground tracking data from radio theodolite and optical television tracking equipment. Flight profiles included completely coupled, descending, curved paths to a close-in intercept (2.0 and 1.1 nautical miles) of runway centerline, followed by autoland and roll-out on runway. Results using the basic narrow system are discussed A R H

N78-28072# National Aviation Facilities Experimental Center, Atlantic City, N J
TRSB MICROWAVE LANDING SYSTEM DEMONSTRATION PROGRAM AT TEGUCIGALPA, HONDURAS Final Report, 13-26 Nov. 1977
 Nov 1977 44 p
 (FAA Proj 075-725-755)
 (AD-A054452, FAA-NA-78-15, FAA-RD-78-15) Avail NTIS HC A03/MF A01 CSCL 01/4

The small community time reference scanning beam (TRSB) microwave landing system was demonstrated at Toncontin Airport in Honduras. This configuration provides azimuth proportional guidance plus or minus 10 degrees about the runway centerline, with directional guidance from 10 degrees out to 40 degrees. Elevation proportional guidance from 2 degrees to 11 degrees, with fly-down clearance from 11 degrees to 15 degrees, is provided. Coverage distance is at least 20 nautical miles under heavy rain. Flights in the NAFEC CV-580 demonstrated three approaches: (1) parallel to runway centerline, offset by 58.5 meters with 4.5 degrees elevation angle, (2) 3 degrees azimuth radial with 4 degrees elevation angle, and (3) 9 degrees azimuth radial with 3.5 degrees elevation angle. In all cases, decision height was 123 meters (400 feet). For this airport and runway, the data indicates that guidance signal quality, with no filtering, is well within ICAO noise requirements for a reduced capability system A R H

N78-28073# National Aviation Facilities Experimental Center, Atlantic City, N J
TRSB MICROWAVE LANDING SYSTEM DEMONSTRATION PROGRAM AT DAKAR, SENEGAL Final Report, 9-15 Feb. 1978
 Feb 1978 54 p
 (AD-A054645, FAA-NA-78-21, FAA-RD-78-21) Avail NTIS HC A04/MF A01 CSCL 17/7

The Time Referenced Scanning Beam (TRSB small community system) was installed on the same runway as a commissioned ILS. Flight checks established that no mutual interference resulted. Operational demonstrations and data acquisition flights were made utilizing an FAA Boeing 727 testbed aircraft. Flight profiles included approaches, radials, and partial orbits perpendicular to the runway centerline. Results of the operational demonstrations indicated that the performance of the TRSB small community system configuration was within the design requirements and met the ICAO full capability system requirements Author

N78-28074# National Aviation Facilities Experimental Center, Atlantic City, N J
TRSB MICROWAVE LANDING SYSTEM DEMONSTRATION PROGRAM AT NAIROBI, KENYA Final Report, 19-25 Feb. 1978

Feb 1978 47 p
 (AD-A054646, FAA-NA-78-22, FAA-RD-78-22) Avail NTIS HC A03/MF A01 CSCL 17/7

The system was flown to Nairobi in an FAA Boeing 727 testbed aircraft and installed on the same runway as a commissioned ILS. Data acquisition and operational demonstration flights were flown with the FAA B 727 aircraft over a period of 5 days (February 20-24 1978). During the flights, a radio telemetry theodolite and an optical electronic tracker were used for aircraft space position data. Flight profiles included straight in approaches at various elevation angles level runs at 1500 feet altitude on centerline, and + or - degree offsets and 10 nautical mile partial orbits at 3500 feet altitude. Results of the flight tests indicate that the performance of the Time Reference Scanning Beam small community system was within design requirements, the ICAO reduced capability system requirements and the ICAO full capability system requirements. The TRSB system installation did not adversely affect the instrument landing system Author

N78-28075# National Aviation Facilities Experimental Center, Atlantic City, N J

AN EVALUATION OF MODIFIED RNAV TERMINAL PROCEDURES USING A SINGLE WAYPOINT RNAV SYSTEM Final Report, Jan - Jun 1978

Donald Eldredge, Bernard Goldberg and William Crimbring Apr 1978 120 p
 (FAA Proj 044-326-340)

(AD-A054510, FAA-NA-77-49, FAA-RD-78-27) Avail NTIS HC A06/MF A01 CSCL 17/7

Nine pilots participated in a series of flight simulation tests employing solo pilot techniques which were conducted in order to measure Total System Crosstrack (TSCT) and Flight Technical Error (FTE) using a single waypoint area navigation (RNAV) system. The tests were designed to assess pilot performance as a function of routes and route structures (consisting of different combinations of waypoints and/or intersections). Performance was measured on the variables: horizontal tracking and procedural performance. The horizontal tracking data included both steady state and transition data Author

N78-28076# Transportation Systems Center, Cambridge, Mass
TOWER-RELATED MAJOR SYSTEM DEVELOPMENT PROGRAMS Interim Report, Apr - Jun 1977

D Clapp, P Rempfer, D Devoe, J Bellantoni, L Stevenson, R Coonan, J Kuhn, J O'Brien, R Bland and J Dumanian Mar 1978 317 p refs

(AD-A054608, DOT-TSC-FAA-78-2, FAA-EM-77-16) Avail NTIS HC A14/MF A01 CSCL 17/7

The present and near future states of the tower cab environment are reported and those MSDP systems which may have an impact on the current tower cab environment systems and/or operations are addressed. The systems included are: Discrete Address Beacon System (DABS), Airport Surface Detection Equipment 3 (ASDE 3), Tower Airport Ground Surveillance (TAGS), Terminal Information Processing System (TIPS), ARTS 2 and ARTS 3 enhancements, Flight Service Station Automation (FSSA), Vortex Advisory System (VAS), Wake Vortex Avoidance System (WVAS), Wind Shear Detection system (WSD) and Microwave Landing System (MLS). Each system is described in terms of its functional objectives, planned equipment interfaces with other systems and with controllers, failure modes and current development/deployment status G Y

N78-28077# Mitre Corp, McLean, Va
IMPACT OF FAA E AND D ELEMENTS EIGHT AIRPORT SUMMARY Final Report

A L Haines Jan 1978 67 p refs
 (Contract DOT-FA78WA-4075)
 (AD-A054245, FAA-EM-78-4, MTR-7350-Vol-3) Avail NTIS HC A04/MF A01 CSCL 17/7

The potential benefits of implementing the products of selected FAA engineering and development programs at eight major airports

were surveyed. Best estimates of the expected performance of the vortex advisory/wake vortex avoidance systems (VAS/WVAS) metering and spacing and the discrete address beacon systems were used as basis for estimating the increase in airport capacity that might be realized from the collective use of those systems in a pre-1985 case and a post-1985 case. Best estimates of the expected performance of the airport surface traffic control (ASTC) system, the microwave landing system (MLS) and area navigation equipment (RNAV) plus results of recent FAA/TSC studies were used as the basis for estimating the individual impacts of those systems on controller workload changes in air routes to reduce time and fuel and ILS interference problems at the eight airports. B B

N78-28079# Intermetrics Inc. Cambridge Mass
COMPARISON OF THREE VERTICAL CHANNEL DESIGNS FOR AN INTEGRATED GPS/INERTIAL NAVIGATION SYSTEM. Interim Report, Dec 1976 - Jul 1977

William S. Widnall and Prasun K. Shinha. Wright Patterson AFB Ohio AFAL Dec 1977 83 p refs
 (Contract F33615-77-C-1044)
 (AD-A053594 IR-234 AFAL-TR-77-208) Avail NTIS HC A05/MF A01 CSCL 17/7

The Integrated GPS/Inertial (IGI) Simulator is utilized to explore design issues associated with the vertical channel of a GPS/baro/inertial navigation system. The assumed navigation system includes a local-level wander azimuth inertial navigation system with associated barometric altimeter for stabilizing the vertical channel, a Global Positioning System (GPS) pseudo range and range-rate receiver and a navigation computer hosting a Kalman filter to integrate the baro/inertial and GPS data. The simulated flight path is an F-4 high dynamic tactical mission profile. Of particular interest in evaluating vertical channel performance is a seven minute period during which jamming prevents the use of GPS measurements. Three Kalman filter designs are evaluated. GRA

N78-28081# National Aviation Facilities Experimental Center
 Atlantic City N J

TESTS OF CRASH-RESISTANT FUEL SYSTEM FOR GENERAL AVIATION. Interim Report, Feb 1976 - Jun 1977

William M. Perrella Jr. Mar 1978 32 p
 (FAA Proj 184-521-100)
 (AD-A054141 FAA-NA-77-48 FAA-RD-78-28) Avail NTIS HC A03/MF A01 CSCL 01/3

A significant percentage of general aviation aircraft accidents result in post-crash fires due to the ignition of fuel spillage, often contributing injury or death to the aircraft occupants. Testing was performed to demonstrate the performance of light-weight, flexible, crash-resistant fuel cells combined with the use of frangible fuel line couplings. Included in these tests were three full-scale crash tests of a typical light twin aircraft. In all of these tests the crash-resistant fuel system performed satisfactorily. Author

N78-28082# Lockheed-California Co., Burbank
FULL SCALE CRASH TEST EXPERIMENT VERIFICATION OF A METHOD OF ANALYSIS FOR GENERAL AVIATION STRUCTURAL CRASHWORTHINESS. Final Report, Jun 1976 - Feb 1978

Gil Wittlin, Max A. Gamon and William L. LaBarge. Feb 1978 392 p refs
 (Contract DOT-FA75WA-3707)
 (AD-A054154 FAA-RD-77-188 LR-28306) Avail NTIS HC A17/MF A01 CSCL 01C

The results to experimentally verify a method of analysis of the structural dynamics response of general aviation airplanes subjected to a crash environment are presented. A description of the preparation for the performance of four instrumented full scale crash tests involving a single engine, high wing type airplane was also included. The crash tests involved a wide range of impact attitudes and included one impact into a soil covered terrain. Program KRASH refined for general aviation airplane application is used to mathematically model the single engine, high wing type airplane for each of the crash tests. An analysis

of each crash condition was performed and the results with regard to post crash sequence, cg velocity energy distribution, cabin deformation, member deflections, structure failures and floor occupant and engine mass accelerations are presented. Correlation between analysis and test results is described for each crash test. Comparisons of analytical and test results are summarized for the composite of all four crash tests. The analytical results are shown to be in agreement with test results. Conclusions are presented following the summary of results. B B

N78-28083*# Gorham Associates, Thousand Oaks, Calif
STUDY TO DETERMINE OPERATIONAL AND PERFORMANCE CRITERIA FOR STOL AIRCRAFT OPERATING IN LOW VISIBILITY CONDITIONS

John A. Gorham. May 1978 63 p refs
 (Contract NAS2-8790)
 (NASA-CR-152164) Avail NTIS HC A04/MF A01 CSCL 01C

The operational and performance criteria for civil CTOL passenger-carrying airplanes landing in low visibilities depend upon the characteristics of the airplane, the nature and use of the ground and airborne guidance and control systems and the geometry and lighting of the landing field. Based upon these criteria, FAA advisory circulars, airplane and equipment design characteristics and airline operational and maintenance procedures were formulated. The documents are selected, described, and discussed in relationship to the potential low weather minima operation of STOL aircraft. An attempt is made to identify fundamental differences between CTOL and STOL aircraft characteristics which could impact upon existing CTOL documentation. Further study and/or flight experiments are recommended. G Y

N78-28084# School of Aerospace Medicine, Brooks AFB, Tex
MULTIPLE IMAGES IN THE F/FB-111 AIRCRAFT WINDSHIELD: THEIR GENERATION, SPATIAL LOCALIZATION, AND RECORDING. Progress Report, Jan 1975 - Jan 1977

Wayne F. Provines, Benjamin Kislin, and Thomas J. Tredici. Dec 1977 20 p refs
 (AD-A053470 SAM-TR-77-32) Avail NTIS HC A02/MF A01 CSCL 01/4

By reviewing basic laws of geometrical optics and applying some fundamentals of physiological optics, one can explain the generation and behavior of multiple images in the F/FB-111 windshield. The refinement of windshield optical laboratory techniques yield information for predicting and recording individual windshield multiple image patterns. GRA

N78-28085# Kaman Avidyne, Burlington Mass
MEASUREMENTS OF BLAST PRESSURES ON A RIGID 65 DEG SWEEPBACK WING AT MACH 0.76 FROM ROCKET PROPELLED SLED TESTS. VOLUME 1. TEST DOCUMENTATION. Final Report, Oct 1975 - May 1977

J. Ray Ruetenik and Robert F. Smiley. 20 Jun 1977 149 p refs
 (Contract DNA001-76-C-0106)
 (AD-A053468 AD-E300184 KA-TR-137-Vol-1 DNA-4400F-1) Avail NTIS HC A07/MF A01 CSCL 19/4

Interaction of a blast wave with a highly sweptback wing model was measured in a series of three sled tests. The sled, traveling at Mach 0.76, was intercepted progressively by blast waves produced from the sequential detonation of three charges of TNT. The model consisted of a sting-mounted wing and fuselage combination. Wing properties were 46.80 in span, 18.95 in mean chord, 2.41 aspect ratio, 0.29 taper ratio, 67 deg leading edge sweepback, 64.8 deg quarter-chord sweepback and a 64 A012 wing section. Blast induced loadings were measured at 20 locations on the wing for blast intercept overpressures of about 2 and 4 PSI for blast intercept angles of about 20, 90 and 135 degrees from head-on. A preliminary analysis of the test data indicates the existence of some non-linear blast-induced loads on the model appreciably greater than would be expected on the basis of linearized aerodynamic theory. GRA

N78-28087# National Aerospace Lab , Amsterdam (Netherlands)
Scientific Services

**AIRFOIL DESIGN BY THE METHOD OF SINGULARITIES
VIA PARAMETRIC OPTIMIZATION OF GEOMETRICALLY
CONSTRAINED LEAST SQUARES OBJECT FUNCTION**

T E Labrujere 6 Jan 1978 19 p refs

(NLR-TR-76139-U) Avail NTIS HC A02/MF A01

A method for the design of airfoils in incompressible flow which subject to geometrical constraints generates approximately given distribution of the pressure coefficient along the projection of the airfoil chord on an axis parallel to the onset flow is described. The flow is simulated by means of a distribution of singularities along the airfoil contour. The method is based on parametric optimization of a constrained least squares error function. The method results in the determination of the a priori unknown airfoil contour together with the strengths of the singularities. Author (ESA)

N78-28088# Advisory Group for Aerospace Research and Development, Paris (France)

**COMBAT DAMAGE TOLERANCE AND REPAIR OF
AIRCRAFT STRUCTURES**

Jun 1978 33 p refs Presented at the 46th Struct and Mater Panel Meeting Aalborg Denmark, Apr 1978

(AGARD-R-667 ISBN-92-835-1286-3) Avail NTIS HC A03/MF A01

The following topics are discussed: (1) approaches to combat damage repair; (2) considerations of the likely tolerance to and repair of battle damage in aircraft structures; and (3) aims and progress of a battle damage repair capability in the Royal Air Force.

N78-28089# Army Research and Technology Labs Fort Eustis, Va Applied Technology Lab

APPROACHES TO COMBAT DAMAGE REPAIR

Thomas L House and John Ariano In AGARD Combat Damage Tolerance and Repair of Aircraft Struct Jun 1978 p 1-10 ref

Avail NTIS HC A03/MF A01

Issues of maintaining helicopters under mid-intensity combat conditions are discussed. The need to defer all but essential scheduled and unscheduled maintenance was addressed with specific interest directed toward minimizing aircraft downtime for combat damage repair. It is apparent that the application of interim quick-fix approaches for certain combat damage repair is needed to achieve an optimum combat maintenance capability. Selected damage repair techniques are discussed requirements for further development in this area are also reviewed. B B

N78-28090# British Aircraft Corp, Warton (England)
**SOME CONSIDERATIONS OF THE LIKELY TOLERANCE TO,
AND REPAIR OF, BATTLE DAMAGE IN COMBAT AIRCRAFT
STRUCTURES**

T Sharples In AGARD Combat Damage Tolerance and Repair of Aircraft Struct Jun 1978 p 11-24

Avail NTIS HC A03/MF A01

Design cases and likely margins of strength on the major structural components of typical combat aircraft were outlined. Levels of allowable damage which may be expected for both sharp-edged and cleaned out holes caused by projectile damage to structural skins were examined. Simple skin repairs are then discussed followed by a suggested format for a structural Battle Damage Manual. B B

N78-28091# Royal Air Force London (England)
**AIMS AND PROGRESS OF A BATTLE DAMAGE REPAIR
CAPABILITY IN THE ROYAL AIR FORCE**

C M Harris In AGARD Combat Damage Tolerance and Repair of Aircraft Struct Jun 1978 p 25-28 ref

Avail NTIS HC A03/MF A01

The background to the RAF's decision to develop a capability to rapidly repair aircraft that were damaged in combat is discussed and features of aircraft design which would simplify battle damage repair were studied. B B

N78-28092# National Aviation Facilities Experimental Center
Atlantic City, N J

**HEAD-UP DISPLAYS A LITERATURE REVIEW AND
ANALYSIS WITH AN ANNOTATED BIBLIOGRAPHY**

Final Report, Oct 1976 - Sep 1977

Jack J Shrager Apr 1978 132 p

(FAA Proj 073-320-510)

(AD-A054246 FAA-NA-77-42 FAA-RD-78-31) Avail NTIS HC A07/MF A01 CSCL 01/4

A bibliographic compilation relating to head-up displays (HUDs) for aircraft cockpit application and a summary of an evaluation of their contents in the areas of human factors, optical techniques, symbology, system concept, safety, simulation and flight test, and other factors or applications are reported. The objective of this in-depth literature review is to determine the appropriate follow up course of action in HUDs as it relates to civil aircraft application using current production HUDs. The results of a state of the art HUD analysis which was also performed simultaneously is also summarized. G Y

N78-28093# Institute for Defense Analyses Arlington Va Cost Analysis Group

**THE FEASIBILITY OF ESTIMATING AVIONICS SUPPORT
COSTS EARLY IN THE ACQUISITION CYCLE VOLUME 2
APPENDIXES Final Report, 17 Jan - Sept 1977**

John D Morgan and Aaron B Fuller Sep 1977 251 p refs (Contract DAH015-73-C-0200)

(AD-A053486, AD-E500026, P-1292-Vol-2)

IDA/HQ-77-19873) Avail NTIS HC A12/MF A01 CSCL 15/5

This paper reports on research to determine the feasibility of developing methods to estimate early in the system acquisition cycle the potential support cost inputs of alternative avionics components envisioned for Air Force and Navy fighter aircraft. Support costs are defined as those costs incurred at the organizational, intermediate and depot levels to maintain avionics equipment and the costs of avionics spares and repair parts support. Volume 2 is a compilation of appendixes containing additional material to support the basic report including summary evaluations of forty-eight key documents encountered in the literature search. GRA

N78-28094# General Electric Co Cincinnati, Ohio Aircraft Engine Group

**ACOUSTIC TESTS OF DUCT-BURNING TURBOFAN JET
NOISE SIMULATION COMPREHENSIVE DATA REPORT.
VOLUME 1, SECTION 1 MODEL SCALE DATA
Final Report**

P H Heck, D Latham, J F Brausch, E J Stringas, P S Staid and P R Knott Aug 1978 477 p

(Contract NAS3-18008)

(NASA-CR-135239-Vol-1-1-Sect-1)

Avail NTIS

HC A21/MF A01 CSCL 21E

Model scale data on a 12.2 m (40 ft) arc are presented which were obtained in the hot static acoustic tests on eleven nozzle designs suitable for use on duct-burning turbofan engines. D L G

N78-28095# General Electric Co Cincinnati, Ohio Aircraft Engine Group

**ACOUSTIC TESTS OF DUCT-BURNING TURBOFAN JET
NOISE SIMULATION COMPREHENSIVE DATA REPORT
VOLUME 1, SECTION 2 FULL SIZE DATA Final Report**

P H Heck, D Latham, J F Brausch, E J Stringas, P S Staid and P R Knott Aug 1978 832 p

(Contract NAS3-18008)

(NASA-CR-135239-Vol-1-1-Sect-2)

Avail NTIS

HC A99/MF A01 CSCL 21E

Acoustic data are presented scaled to a full size engine by a factor of 8 on a 96.9 m (320 ft) arc and a 731.5 m (2400 ft) sideline. D L G

N78-28096# General Electric Co Cincinnati, Ohio Aircraft Engine Group

**ACOUSTIC TESTS OF DUCT-BURNING TURBOFAN JET
NOISE SIMULATION COMPREHENSIVE DATA REPORT
VOLUME 1, SECTION 3 DATA PLOTS Final Report**

P H Heck, D Latham, J F Brausch, E J Stringas, P S Staid and P R Knott Aug 1978 520 p
(Contract NAS3-18008)
(NASA-CR-135239-Vol-1-Sect-3) Avail NTIS
HC A22/MF A01 CSCL 21E

Acoustic data plots are presented which were obtained in the tests on scale nozzles for use on duct-burning turbofan engines
DLG

N78-28097* General Electric Co Cincinnati, Ohio Aircraft Engine Group
ACOUSTIC TESTS OF DUCT-BURNING TURBOFAN JET NOISE SIMULATION COMPREHENSIVE DATA REPORT VOLUME 2 MODEL DESIGN AND AERODYNAMIC TEST RESULTS Final Report

P H Heck, D Latham, J F Brausch, E J Stringas, P S Staid and P R Knott Aug 1978 229 p refs
(Contract NAS3-18008)
(NASA-CR-135239-Vol-2) Avail NTIS HC A11/MF A01 CSCL 21E

The selection procedure is described which was used to arrive at the configurations tested, and the performance characteristics of the test nozzles are given
DLG

N78-28098* General Applied Science Labs Inc Westbury, N Y

EXPERIMENTAL STUDY OF THE EFFECT OF CYCLE PRESSURE ON LEAN COMBUSTION EMISSIONS Final Report

Gerald Roffe and K S Venkataramani Washington NASA Jul 1978 51 p
(Contract NAS3-20581)
(NASA-CR-3032 GASL-TR-248) Avail NTIS
HC A04/MF A01 CSCL 21E

Experiments were conducted in which a stream of premixed propane and air was burned under conditions representative of gas turbine operation. Emissions of NO_x, CO and unburned hydrocarbons (UHC) were measured over a range of combustor inlet temperature, pressure and residence time at equivalence ratios from 0.7 down to the lean stability limit. At an inlet temperature of 600 K, observed NO_x levels dropped markedly with decreasing pressure for pressures below 20 atm. The NO_x levels are proportional to combustor residence time and formation rates were principally a function of adiabatic flame temperature. For adiabatic flame temperatures of 2050 K and higher, CO reached chemical equilibrium within 2 msec. Unburned hydrocarbon species dropped to a negligible level within 2 msec regardless of inlet temperature, pressure or equivalence ratio. For a combustor residence time of 2.5 msec, combustion inefficiency became less than 0.01% at an adiabatic flame temperature of 2050 K. The maximum combustion inefficiency observed was on the order of 1% and corresponded to conditions near the lean stability limit. Using a perforated plate flameholder, this limit is well represented by the condition of 1800 K adiabatic flame temperature
Author

N78-28101* National Aeronautics and Space Administration Langley Research Center Langley Station Va
USER'S GUIDE FOR A MODULAR FLUTTER ANALYSIS SOFTWARE SYSTEM (FAST VERSION 1.0)

Robert N Desmarais and Robert M Bennett May 1978 147 p refs
(NASA-TM-78720) Avail NTIS HC A07/MF A01 CSCL 01C

The use and operation of a group of computer programs to perform a flutter analysis of a single planar wing are described. This system of programs is called FAST for Flutter Analysis System and consists of five programs. Each program performs certain portions of a flutter analysis and can be run sequentially as a job step or individually. FAST uses natural vibration modes as input data and performs a conventional V-g type of solution. The unsteady aerodynamics programs in FAST are based on the subsonic kernel function lifting-surface theory although other aerodynamic programs can be used. Application of the programs is illustrated by a sample case of a complete flutter calculation that exercises each program
G Y

N78-28275# Textron Bell Aerospace Co Buffalo, N Y
PILOT MODEL AIR CUSHION VEHICLE (LACV-30) PROGRAM Final Technical Report, Mar 1975 - Feb 1978

Robert P Kaiser Feb 1978 15 p refs
(Contract DAAK02-75-C-0149)
(AD-A053686 BAC-7467-928010) Avail NTIS
HC A02/MF A01 CSCL 01/3

This report presents summaries of seven Final Reports of vehicle subsystem and model test investigations performed by Bell Aerospace Textron under the Pilot Model Air Cushion Vehicle (LACV-30) Contract No DAAK 02-75-C-0149. Summaries are also presented of six BAT IR and D investigations of its Stretched Voyageur vehicle which have some relevance to the LACV-30
Author (GRA)

N78-28276# Textron Bell Aerospace Co Buffalo, N Y
LACV-30 TEST AND DEMONSTRATION REPORT Final Report

Marion M Laszewski Feb 1978 161 p refs
(Contract DAAK02-75-C-0149)
(AD-A053610 BAC-7467-928009) Avail NTIS
HC A08/MF A01 CSCL 01/3

This report presents the test data and analysis of all acceptance and type tests performed on the LACV-30-1 and -2 vehicles. The tests were performed as specified in Contract No DAAK02-75-C-0149 dated 7 March 1975. All test data were accepted by the U.S. Army prior to delivery of the vehicles. Two corrective actions were required on the LACV-30-1 installation of a new horn and addition of bow pre-loaders to maintain pressure on the front landing pads during swing crane operation
Author (GRA)

N78-28277# Textron Bell Aerospace Co Buffalo, N Y
LACV-30 AUXILIARY POWER UNIT INVESTIGATION Final Technical Report, Sep 1976 - Jan 1977

Robert P Kaiser Jun 1977 97 p
(Contract DAAK02-75-C-0149)
(AD-A053566 BAC-7467-927024) Avail NTIS
HC A05/MF A01 CSCL 10/2

An investigation was performed to determine the cause and solution to a series of Auxiliary Power Unit (APU) failures on LACV-30 vehicles. Vibration and other measurements were made on the complete installation, the APU module alone and the engine alone. It was concluded that the APU module arrangement reinforced or excited an engine vibration mode to destructive amplitudes. The problem was solved by modifying the APU to virtually eliminate this vibration
Author (GRA)

N78-28278# Army Natick Research and Development Command, Mass

ACCORDION SHELTER HARDWARE ANALYSIS Final Report, Feb 1976 - Aug 1977

Predrag Shopalovich and Franklin Barca Feb 1978 37 p refs
(DA Proj 1L7-62723-A-42701)
(AD-A053592 NATICK/TR-78/011) Avail NTIS
HC A03/MF A01 CSCL 13/13

This report presents the results of an investigation into some of the hardware difficulties experienced with the accordion shelter during field tests. The accordion shelter is a prototype rigid-wall general purpose expandable military shelter. In the closed transportation configuration the shelter serves as its own shipping container and conforms to the dimensional and strength requirements of the International Organization for Standardization Type IC freight container. In the habitation mode the container expands from both sides to form an enclosed, environmentally controlled, lighted shelter approximately 2.4 metres high by 2.4 metres wide by 15.2 metres long. The main problem areas are identified as container jacks, floor jacks, leveling system and expansion system. The specific causes of the problems are identified and solutions to the problems are proposed
Author (GRA)

N78-28279# Army Cold Regions Research and Engineering Lab Hanover N H
FREEZE-THAW TESTS OF LIQUID DEICING CHEMICALS ON SELECTED PAVEMENT MATERIALS
 L David Minsk Nov 1977 24 p
 (AD-A051771 CRREL-77-28) Avail NTIS HC A02/MF A01 CSCL 13/2

Tests were conducted to assess the extent of surface degradation resulting from the application of non-chloride deicing chemicals on three types of airfield pavements. The chemicals tested were proprietary mixtures of urea formamide and ethylene glycol sodium chloride distilled water and dry specimens were used as controls and for comparison. Pavements included new and old specimens of open-graded asphaltic concrete and old specimens of dense-graded asphaltic concrete. Portland cement concrete specimens used were new and old with and without air-entrainment. New and old tar rubber concrete specimens were also tested. Samples were subjected to up to 60 freeze-thaw cycles with deicing chemicals flooding their upper surface. Each specimen was rated on a scale of 0-5 after every five freeze-thaw cycles. All PCC specimens showed some surface degradation whereas the dense- and open-graded asphaltic concretes were largely unaffected. Author (GRA)

N78-28295# Electromagnetic Compatibility Analysis Center Annapolis Md
FAA REMOTE TERMINAL SYSTEM Final Report
 Thomas Hensler (IIT Research Inst Annapolis) Nov 1977 103 p refs
 (Contracts DOT-FA76WAI-612)
 (AD-A054604, ECAC-PR-77-067 FAA-RD-78-8) Avail NTIS HC A06/MF A01 CSCL 09/3

A system of interactive analysis programs was developed that provides automated quick-response capabilities for use by frequency managers to solve daily frequency management problems. The system can be used to display records from the FAA Air Traffic Control (ATC) data base provide electromagnetic compatibility analyses make frequency assignments and plot service volumes. G G

N78-28296# Westinghouse Defense and Electronic Systems Center, Baltimore Md
ANALYSIS OF THE PERFORMANCE OF IMAGE GLIDE SLOPE ANTENNA IN THE PRESENCE OF TRUNCATED GROUND Interim Report
 J T Godfrey R A Moore G J Moussally and H F Hartley Mar 1978 77 p refs
 (Contract DOT-FA74WA-3353)
 (AD-A054415 FAA-RD-78-43) Avail NTIS HC A05/MF A01 CSCL 09/1

An analysis was performed to permit the calculation of fields of dipoles at any orientation over lateral or transverse conducting half planes and over multiple contiguous strips of arbitrary tilt angle. Computer programs were developed to calculate DDM over terrain types from half planes and strips. Glide path DDM calculations over typical terrain types for the three image type glide slope systems were computed. G Y

N78-28297# Electromagnetic Compatibility Analysis Center Annapolis, Md
AN EMC ANALYSIS OF THE PROPOSED ASDE-3 AIRPORT SURFACE DETECTION EQUIPMENT RADAR Final Report, Apr - Nov 1976
 J G Preis Jr (IIT Res Inst Annapolis) and T Malicka (IIT Res Inst Annapolis) Dec 1977 63 p refs
 (Contracts DOT-FA70WAI-175 F19628-78-C-0006)
 (AD-A054607, ECAC-PR-76-078 FAA-RD-77-183) Avail NTIS HC A04/MF A01 CSCL 17/9

The electromagnetic compatibility between airport surface detection equipment (ASDE-3) radars to be located at major US commercial airports and the communications-electronics equipments near proposed ASDE-3 sites are studied. Three types of the environmental equipment are considered ground-based equipment aircraft landing systems, and airborne equipments. Predicted interfering signal levels were compared against

established receiver interference thresholds to determine interference problems, and frequency management techniques were identified as potential solutions to the problems. It is determined that the recommended solutions are applicable regardless of whether ASDE-3 operates in the single-frequency or the frequency-agile mode. G G

N78-28349# Sandia Labs Albuquerque, N Mex
INTERACTION OF THICK FILM DIELECTRIC, CONDUCTOR, AND ALUMINA SUBSTRATE FOR DCU201 AIRCRAFT CONTROLLER
 Sharon S White Feb 1978 27 p refs
 (Contract EY-76-C-04-0789)
 (SAND-78-0069) Avail NTIS HC A03/MF A01

A multilayer thick film system committed for use in the DCU201 aircraft controller was examined by stress, electron microprobe X-ray wet chemical, and insulation resistance analyses. Even after rigorous multilayer processing, which requires up to eight firings of portions of the system, no problems were discerned in the areas of stress distribution, materials diffusion between different layers and electrical conduction within dielectric layers. ERA

N78-28399# Avions Marcel Dassault-Breguet Aviation Saint-Cloud (France)
BOUNDARY SEPARATION PROBLEMS FACED BY AIRCRAFT DESIGNERS [LES PROBLEMES DE DECOLLEMENTS POSES A L'AVIONNEUR]
 Pierre Perrier In AGARD Three Dimensional and Unsteady Separation at High Reynolds No Feb 1978 11 p refs In FRENCH
 Avail NTIS HC A11/MF A01

Various forms of boundary separation problems in relation to quality flight performance and aircraft design were studied. Experimental methods to resolve these problems were analyzed in detail. Transl by B B

N78-28402*# National Aeronautics and Space Administration Ames Research Center Moffett Field, Calif
PHENOMENOLOGICAL ASPECTS OF QUASI-STATIONARY CONTROLLED AND UNCONTROLLED THREE-DIMENSIONAL FLOW SEPARATIONS
 David J Peake In AGARD Three Dimensional and Unsteady Separation at High Reynolds No Feb 1978 52 p refs

Avail NTIS HC A11/MF A01 CSCL 20D

Quasi-steady three dimensional separated flows about bodies of large fineness ratio operating at large angles of incidence or yaw are discussed. The general character of the three dimensional attached boundary layer the concept of limiting streamlines, and the physics of three dimensional separation and reattachment are among the factors considered. Specific examples are given. The advantages of swept, sharp edges that generate controlled (or fixed) three dimensional flow separations on a vehicle due to the qualitatively unchanging flow field developed throughout the range of flight conditions are emphasized. J M S

N78-28404# Royal Aircraft Establishment, Bedford (England)
PREDICTION OF THE SEVERITY OF BUFFETING
 D G Mabey In AGARD Three Dimensional and Unsteady Separation at High Reynolds No Feb 1978 30 p refs

Avail NTIS HC A11/MF A01

The influence of buffeting criteria on the choice of wing loading for fighter and transport aircraft is discussed. Wings are classified in terms of flow separations and buffeting. Wind tunnel model tests used to predict aircraft buffeting are described with emphasis on the importance of using wind tunnels with low levels of flow unsteadiness. Factors measured in the model tests include unsteady wing-root strain in the first bending mode, unsteady pressure across the surface, and unsteady responses. Alternative methods of determining buffet onset are also considered. J M S

N78-28405*# National Aeronautics and Space Administration Ames Research Center Moffett Field Calif

SOME UNSTEADY SEPARATION PROBLEMS FOR SLENDER BODIES

W J McCroskey /In AGARD Three Dimensional and Unsteady Separation at High Reynolds No Feb 1978 11 p refs

Avail NTIS HC A11/MF A01 CSCL 20D

The unsteady Kutta-Joukowski condition, dynamic stall on oscillating airfoils, and unsteady shock wave-boundary layer interaction are discussed. Emphasis is placed on developing reliable prediction techniques and suppression of unsteady separation on oscillating control surfaces wings and rotating blades to improve aerodynamic stability J M S

**N78-28406# Royal Aircraft Establishment Farnborough (England) Dept of Aerodynamics
INVISCID FLUID MODEL, BASED ON ROLLED-UP VORTEX SHEETS, FOR THREE-DIMENSIONAL SEPARATION AT HIGH REYNOLDS NUMBER**

J H B Smith /In AGARD Three Dimensional and Unsteady Separation at High Reynolds No Feb 1978 27 p refs

Avail NTIS HC A11/MF A01

The inviscid fluid models which are used to represent flows with three dimensional separation of vortex type are introduced and described. Their strengths and weaknesses are discussed and suggestions are made for improvements. A selection of results for a wide range of problems is presented. The difficulties which arise in trying to extend these models to represent separation from highly swept separation lines on smooth bodies are discussed and a view is given of the present position and developments in the immediate future J M S

**N78-28407# Imperial Coll of Science and Technology London (England)
STRUCTURE OF TURBULENCE IN COMPLEX FLOWS**

P Bradshaw /In AGARD Three Dimensional and Unsteady Separation at High Reynolds No Feb 1978 7 p refs

Avail NTIS HC A11/MF A01

The effects of unsteadiness or three dimensionality on turbulence and turbulence models are discussed. The response of shear layers to extra rates of strain is outlined and the concept of the fairly thin shear layer presented. The special problems of separated flow are briefly reviewed J M S

N78-28409*# National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif

PREDICTION OF UNSTEADY SEPARATED FLOWS ON OSCILLATING AIRFOILS

W J McCroskey /In AGARD Three Dimensional and Unsteady Separation at High Reynolds No Feb 1978 8 p refs

Avail NTIS HC A11/MF A01 CSCL 20D

Techniques for calculating high Reynolds number flow around an airfoil undergoing dynamic stall are reviewed. Emphasis is placed on predicting the values of lift, drag, and pitching moments. Methods discussed include the discrete potential vortex method, thin boundary layer method, strong interaction between inviscid and viscous flows, and solutions to the Navier-Stokes equations. Empirical methods for estimating unsteady airloads on oscillating airfoils are also described. These methods correlate force and moment data from wind tunnel tests to indicate the effects of various parameters, such as airfoil shape, Mach number, amplitude and frequency of sinusoidal oscillations, mean angle, and type of motion J M S

N78-28410*# National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif

STATUS AND FUTURE PROSPECTS OF USING NUMERICAL METHODS TO STUDY COMPLEX FLOWS AT HIGH REYNOLDS NUMBERS

Robert W McCormack /In AGARD Three Dimensional and Unsteady Separation at High Reynolds No Feb 1978 2 p

Avail NTIS HC A11/MF A01 CSCL 20D

The calculation of flow fields past aircraft configuration at high Reynolds numbers is considered. Progress in devising

accurate and efficient numerical methods in understanding and modeling the physics of turbulence and in developing reliable and powerful computer hardware is discussed. Emphasis is placed on efficient solutions to the Navier-Stokes equations J M S

**N78-28484# Kaman Avidyne Burlington Mass
ANALYTICAL PREDICTIONS AND CORRELATION WITH EXPERIMENTS FOR THERMAL/BLAST EXPOSURE OF AIRCRAFT PANELS Final Report, 15 Dec 1975 - 30 Sep 1976**

Raffi P Yeghiayan Jul 1977 96 p refs

(Contract DNA001-75-C-0179)

(AD-A053389 AD-E300171 KA-TR-142 DNA-4446F) Avail NTIS HC A05/MF A01 CSCL 01/3

A study of the effects of thermal/blast exposure on representative aircraft panels was carried out. Pre-test planning and analytic predictions were carried out and compared with the experimental results obtained. Correlation with experimental results was good for the individual effects of internal pressurization or blast overpressure on panels but correlation proved to be a difficult task for experiments involving thermal exposure, which have a low confidence level GRA

N78-28494# National Aerospace Lab, Amsterdam (Netherlands) Structures and Materials Div

REVIEW OF AERONAUTICAL FATIGUE INVESTIGATIONS IN THE NETHERLANDS DURING THE PERIOD APRIL 1975 TO FEBRUARY 1977

J Schijve Feb 1977 43 p refs Presented at the 15th ICAF Conf Darmstadt West Ger 9-10 May 1977

(NLR-MP-77005-U) Avail NTIS HC A03/MF A01

The review consisting of summaries of the Dutch contribution to the 15th ICAF conference May 1977 covers loads, flight simulation testing procedures, fatigue investigations, residual strength, and materials evaluations ESA

N78-28495# National Aerospace Lab, Amsterdam (Netherlands) Structures and Materials Div

EFFECTS OF CRACK PLANE ORIENTATION TRANSITIONS ON FLIGHT SIMULATION FATIGUE CRACK PROPAGATION IN A HIGH STRENGTH ALUMINIUM ALLOY (7050)

R J H Wanhill and L Schra Oct 1976 23 p refs

(Contract NIVR-1806)

(NLR-TR-76130-U) Avail NTIS HC A02/MF A01

The effects of flat to slant fracture transitions on flight simulation fatigue crack propagation in specimens of 7050 aluminum alloy forgings are discussed. For specimens containing flat shear-lipped or full slant fractures at similar crack lengths the crack resistance (R curve) approach appears to provide an explanation for differences in the static crack growth increments induced by peak loads. The results emphasize the complexity of fatigue under realistic loading and add another variable to environmental effects Author (ESA)

N78-28680*# National Aeronautics and Space Administration Langley Research Center, Langley Station, Va

A SUBJECTIVE FIELD STUDY OF HELICOPTER BLADE-SLAP NOISE

Clemens A Powell Jul 1978 88 p refs Sponsored in part by FAA

(NASA-TM-78758) Avail NTIS HC A05/MF A01 CSCL 20A

The effects of impulsiveness on the noisiness of helicopters are examined by varying the main rotor speed while maintaining a constant airspeed. This resulted in other characteristics of the noise being held relatively constant. Other controlled variables included altitude, side line distance, descent operations, and level flyovers. A description is provided of the concept, experimental design and procedures along with results based on partial analyses of acoustic and subjective response data. No significant improvement in the noisiness predictive ability of EPNL was provided by either proposed or an A-weighted crest factor correction for impulsiveness G G

N78-28830*# Vought Corp., Hampton Va
PLOTIT-METHOD OF INTERACTIVELY PLOTTING INPUT DATA FOR THE VORLAX COMPUTER PROGRAM

Frederick M Denn Jun 1978 44 p ref
 (Contract NAS1-13500)
 (NASA-CR-158896) Avail NTIS HC A03/MF A01 CSDL 09B

Geometric input plotting to the VORLAX computer program by means of an interactive remote terminal is reported. The software consists of a procedure file and two programs. The programs and procedure file are described and a sample execution is presented. G G

N78-28861*# Bolt, Beranek, and Newman Inc Cambridge Mass

ANALYSIS AND IN-SIMULATOR EVALUATION OF DISPLAY AND CONTROL CONCEPTS FOR A TERMINAL CONFIGURED VEHICLE IN FINAL APPROACH IN A WINDSHEAR ENVIRONMENT Final Report

William H Levison Washington NASA Aug 1978 98 p refs
 (Contract NAS1-13842)

(NASA-CR-3034) Avail NTIS HC A05/MF A01 CSDL 12B
 Display Control configurations for the Terminal configured Vehicle in approach to landing situations were analyzed. A pilot/vehicle model was used to compare with a real time simulation study. Model results are presented and extended for the approach task during wind shear and random turbulence environments. In general, model results of performance trends matched those obtained experimentally. J M S

N78-28887*# Douglas Aircraft Co Inc Long Beach Calif
AIRFRAME NOISE OF THE DC-9-31 Final Report

A B Bauer and A G Munson Jul 1978 54 p refs
 (Contract NAS1-14696)
 (NASA-CR-3027) Avail NTIS HC A04/MF A01 CSDL 20A

Airframe noise measurements are reported for the DC-9-31 aircraft flown at several speeds and with a number of flap landing gear, and slat extension configurations. The data are corrected for wind effects, atmospheric attenuation, and spherical divergence and are normalized to a 1 meter acoustic range. The sound pressure levels are found to vary approximately as the fifth power of flight velocity. Both lift and drag dipoles exist as a significant part of the airframe noise. The sideline data imply that a significant side-force dipole exists only for the flap- and gear-down configurations; for others, the data imply the existence of only the lift and drag dipoles. The data are compared with airframe noise predictions using the drag element and the data analysis methods. Although some of the predictions are good, further work is needed to refine the methods, particularly for the flap- and gear-down configurations. Author

N78-28888# Aerospace Medical Research Labs Wright-Patterson AFB, Ohio

COMMUNITY NOISE EXPOSURE RESULTING FROM AIRCRAFT OPERATIONS VOLUME 3 ACOUSTIC DATA ON MILITARY AIRCRAFT, AIR FORCE ATTACK/FIGHTER AIRCRAFT

Jerry D Speakman, Robert G Powell, and Robert A Lee Feb 1978 763 p ref
 (AF Proj 7231)
 (AD-A053701, AMRL-TR-73-110-Vol-3) Avail NTIS HC A99/MF A01 CSDL 01/2

This report presents the results of field test measurements to define the noise produced on the ground by military fixed wing aircraft during controlled level flyovers and ground runups. For flight conditions, data are presented in terms of various acoustic measures over the range 200-25,000 feet minimum slant distance to the aircraft. For ground runups, data are presented as a function of angle and distance to the aircraft. All of the data are normalized to standard acoustic reference conditions of 59 F temperature and 70% relative humidity. Noise data are presented in this Volume 3 for the following aircraft: A-7D, E, A-10A, A-37B, F-4C, D, E, F, F-5A, B, F-5E, F, F-15A, F-16A, F-104C, D, G, F-111A, E, F-111D, and F-111F. GRA

N78-28889# Aerospace Medical Research Labs, Wright-Patterson AFB, Ohio

COMMUNITY NOISE EXPOSURE RESULTING FROM AIRCRAFT OPERATIONS VOLUME 2. ACOUSTIC DATA ON MILITARY AIRCRAFT, AIR FORCE BOMBER/CARGO AIRCRAFT

Jerry D Speakman, Robert G Powell, and Robert A Lee Nov 1977 768 p ref
 (AF Proj 7231)
 (AD-A053700, AMRL-TR-73-110-Vol-2) Avail NTIS HC A99/MF A01 CSDL 01/2

This report presents the results of field test measurements to define the single event noise produced on the ground by military fixed wing aircraft during controlled level flyovers and ground runups. For flight conditions, data are presented in terms of various acoustic measures over the range 200-25,000 feet minimum slant distance to the aircraft. For ground runups, data are presented as a function of angle and distance to the aircraft. All of the data are normalized to standard acoustic reference conditions of 59 F temperature and 70% relative humidity. Noise data are presented in this Volume 2 for the following aircraft: B-1, B-52B, C, D, E, B-52G, F, B-52H, B-57B, C, E, FB-111A, C-5A, C-9A, C, C-135A, D, F, G, H, K, L, N, Q, R, T, C-135B, C, E, J, M, S, U, V, C-140A, B, C-141A, and SR-71. GRA

N78-28893# Aerospace Medical Research Labs Wright-Patterson AFB, Ohio

USAF BIOENVIRONMENTAL NOISE DATA HANDBOOK VOLUME 83 KC-135A AIRCRAFT, NEAR AND FAR-FIELD NOISE

Robert G Powell Dec 1977 156 p
 (AF Proj 7231)
 (AD-A054138, AMRL-TR-75-50-Vol-83) Avail NTIS HC A08/MF A01 CSDL 01/2

The USAF KC-135A is a long range high performance tanker aircraft powered by four J57-P-43W or 59W turbojet engines. This report provides measured and extrapolated data defining the bioacoustic environments produced by this aircraft operating on a concrete runup pad for six engine/power configurations. Near-field data are reported for eleven locations in a wide variety of physical and psychoacoustic measures: overall and band sound pressure levels, C-weighted and A-weighted sound levels, preferred speech interference level, perceived noise level, and limiting times for total daily exposure of personnel with and without standard Air Force ear protectors. Far-field data measured at 19 locations are normalized to standard meteorological conditions and extrapolated from 75-8000 meters to derive sets of equal-value contours for these same seven acoustic measures as functions of angle and distance from the source. Refer to Volume 1 of this handbook, USAF Bioenvironmental Noise Data Handbook, Vol 1 Organization Content and Application, AMRL-TR-75-50(1) 1975, for discussion of the objective and design. GRA

N78-28894# Bolt, Beranek and Newman, Inc Cambridge Mass
SOUND OF LOW-SPEED FANS

B E Murray and E W Wood 1977 15 p refs. Presented at the Meeting of the Cooling Tower Inst, Houston Tex, 31 Jan 1977.
 (CONF-770151-7) Avail NTIS HC A02/MF A01

A general view of reported studies and prediction techniques for cooling tower noise is given. Fan noise generation is discussed with respect to the control of low- to mid-frequency noise from mechanical draft cooling towers. An exploratory aerodynamic analysis of fan noise generation is provided leading to empirical relationships for trailing-edge turbulent boundary layer noise, a major noise source in propeller fans. Aeroacoustic means for reducing the sound power output of a fan are discussed. ERA

N78-28979*# National Aeronautics and Space Administration Ames Research Center Moffett Field Calif

PROJECT PLAN FOR JOINT FAA/NASA HEAD-UP DISPLAY CONCEPT EVALUATION

R F Haines Aug 1978 16 p. Sponsored in part by DOT (NASA-TM-78512 HUD-1, A-7562) Avail NTIS HC A02/MF A01 CSDL 05A

Head-Up Display (HUD) concept for large commercial turbojet transport aircraft is considered for its contribution to aviation safety in the form of improved performance during the approach and landing phase flight. The basic research areas represent fundamental questions that are still unresolved and which were considered important to the effective use of the HUD by pilots. Project documentation and management responsibilities are outlined. G G

N78-28986*# National Aeronautics and Space Administration
Lewis Research Center Cleveland Ohio
BIBLIOGRAPHY OF LEWIS RESEARCH CENTER TECHNICAL PUBLICATIONS ANNOUNCED IN 1977
Washington May 1978 348 p
(NASA-TM-78918 E-9449-2) Avail NTIS HC A15/MF A01 CSCL 05B

This compilation of abstracts describes and indexes over 780 technical reports resulting from the scientific and engineering work performed and managed by the Lewis Research Center in 1977. All the publications were announced in the 1977 issues of STAR (Scientific and Technical Aerospace Reports) and/or IAA (International Aerospace Abstracts). Documents cited include research reports, journal articles, conference presentations, patents and patent applications and theses. A R H

N78-29044*# National Aeronautics and Space Administration
Ames Research Center Moffett Field Calif
AN EXPERIMENTAL INVESTIGATION OF HINGELESS HELICOPTER ROTOR-BODY STABILITY IN HOVER
William G Bousman Jun 1978 49 p refs Prepared in cooperation with US Army Aviation Research and Development Command, St Louis Mo
(NASA-TM-78489 AVRADCOM-TR-78-17(AM) A-7430) Avail NTIS HC A03/MF A01 CSCL 02A

Model tests of a 1.62 m diameter rotor were performed to investigate the aeromechanical stability of coupled rotor-body systems in hover. Experimental measurements were made of modal frequencies and damping over a wide range of rotor speeds. Good data were obtained for the frequencies of the rotor lead-lag regressing mode. The quality of the damping measurements of the body modes was poor due to nonlinear damping in the gimbal ball bearings. Simulated vacuum testing was performed using substitute blades of tantalum that reduced the effective lock number to 0.2% of the model scale value while keeping the blade inertia constant. The experimental data were compared with theoretical predictions and the correlation was in general very good. Author

N78-29046*# National Aeronautics and Space Administration
Langley Research Center Langley Station Va
CTOL TRANSPORT TECHNOLOGY, 1978
1978 405 p refs Conf held at Hampton Va 28 Feb 3 Mar 1978
(NASA-CP-2036-Pt-2 L-12178) Avail NTIS HC A18/MF A01 CSCL 02A

Technology associated with advanced conventional takeoff and landing transport aircraft is discussed. Topics covered include advanced aerodynamics and active controls, operations and safety, and advanced systems. Emphasis is placed on increased energy efficiency. 29064

N78-29047*# National Aeronautics and Space Administration
Langley Research Center Langley Station Va
ADVANCED AERODYNAMICS AND ACTIVE CONTROLS TECHNOLOGY
William J Alford, Jr In its CTOL Transport Technol 1978 1978 p 523-531 refs

Avail NTIS HC A18/MF A01 CSCL 02A

The results status and plans of NASA sponsored advanced aerodynamics and active controls technology activities are reported. Development of subsonic, energy efficient transport aircraft technologies is emphasized. J M S

N78-29048*# National Aeronautics and Space Administration
Langley Research Center Langley Station Va
EXPERIMENTAL RESULTS OF WINGLETS ON FIRST, SECOND, AND THIRD GENERATION JET TRANSPORTS

Stuart G Flechner and Peter F Jacobs In its CTOL Transport Technol 1978 1978 p 553-569 refs

Avail NTIS HC A18/MF A01 CSCL 01C

Results of wind tunnel investigations of four jet transport configurations representing both narrow and wide-body configurations and also a future advanced aerodynamic configuration are presented including performance and wing root bending moment data. The effects of winglets on the aerodynamic characteristics throughout the flight envelope were studied. The results indicate that winglets improved the cruise lift to drag ratio between 4 and 8 percent depending on the transport configuration. The data also indicate that ratios of relative aerodynamic gain to relative structural weight penalty for winglets are 1.5 to 2.5 times those for wing-tip extensions. Over the complete range of flight conditions, winglets produce no adverse effects on buffet onset, lateral-directional stability and aileron control effectiveness. J M S

N78-29049*# Douglas Aircraft Co Inc, Long Beach Calif
WINGLET AND LONG DUCT NACELLE AERODYNAMIC DEVELOPMENT FOR DC-10 DERIVATIVES
A Brian Taylor In NASA Langley Res Center CTOL Transport Technol 1978 1978 p 609-623 refs

(Contract NAS1-14743)

Avail NTIS HC A18/MF A01 CSCL 01A

Advanced technology for application to the Douglas DC-10 transport is discussed. Results of wind tunnel tests indicate that the winglet offers substantial cruise drag reduction with less wing root bending moment penalty than a wing-tip extension of the same effectiveness and that the long duct nacelle offers substantial drag reduction potential as a result of aerodynamic and propulsion improvements. The aerodynamic design and test of the nacelle and pylon installation are described. J M S

N78-29050*# Boeing Commercial Airplane Co Seattle Wash
APPLICATION OF WINGLETS AND/OR WING TIP EXTENSIONS WITH ACTIVE LOAD CONTROL ON THE BOEING 747

Robert L Allison, Brian R Perkin and Richard L Schoenman In NASA Langley Res Center CTOL Transport Technol 1978 1978 p 625-646 refs

(Contract NAS1-14741)

Avail NTIS HC A18/MF A01 CSCL 01C

The application of wing tip modifications and active control technology to the Boeing 747 airplane for the purpose of improving fuel efficiency is considered. Wing tip extensions, wing tip winglets and the use of the outboard ailerons for active wing load alleviation are described. Modest performance improvements are indicated. A costs versus benefits approach is taken to decide which, if any, of the concepts warrant further development and flight test leading to possible incorporation into production airplanes. J M S

N78-29051*# Lockheed-California Co San Diego
DEVELOPMENT AND FLIGHT EVALUATION OF ACTIVE CONTROLS IN THE L-1011

J F Johnston and D M Urie In NASA Langley Res Center CTOL Transport Technol 1978 1978 p 647-685 refs

Avail NTIS HC A18/MF A01 CSCL 01C

Active controls in the Lockheed L-1011 for increased energy efficiency are discussed. Active wing load alleviation for extended span, increased aspect ratio and active stability augmentation with a smaller tail for reduced drag and weight are among the topics considered. Flight tests of active wing load alleviation on the baseline aircraft and moving-base piloted simulation developing criteria for stability augmentation are described. J M S

N78-29052*# Douglas Aircraft Co Inc Long Beach Calif
**ADVANCED AERODYNAMICS AND ACTIVE CONTROLS
 FOR A NEXT GENERATION TRANSPORT**
 A Brian Taylor /In NASA Langley Res Center CTOL Transport
 Technol 1978 1978 p 687-708 refs

(Contract NAS1-14744)

Avail NTIS HC A18/MF A01 CSCL 01A

In aerodynamics the use of new and flexible tools for the design of supercritical wings is discussed Trends in the design and performance of highlift devices are outlined In the field of active controls the determination of suitable configurations with regard to flying qualities is described particularly related to results from a piloted simulation J M S

N78-29053*# Boeing Commercial Airplane Co Seattle Wash
**ACTIVE CONTROLS TECHNOLOGY TO MAXIMIZE
 STRUCTURAL EFFICIENCY**

James M Hoy and James M Arnold (Boeing Co Wichita Kans)
 /In NASA Langley Res Center CTOL Transport Technol 1978
 1978 p 709-732 refs

Avail NTIS HC A18/MF A01 CSCL 01C

The implication of the dependence on active controls technology during the design phase of transport structures is considered Critical loading conditions are discussed along with probable ways of alleviating these loads Why fatigue requirements may be critical and can only be partially alleviated is explained The significance of certain flutter suppression system criteria is examined J M S

N78-29054*# National Aeronautics and Space Administration
 Washington D C

OVERVIEW OF SAFETY RESEARCH

John H Enders /In NASA Langley Res Center CTOL Transport
 Technol 1978 1978 p 735-756 refs

Avail NTIS HC A18/MF A01 CSCL 01C

Aircraft safety is reviewed by first establishing a perspective of air transportation accidents as a function of calendar year geographic area and phase of flight and then by describing the threats to safety and NASA research underway in the three representative areas of engine operational problems meteorological phenomena and fire Engine rotor burst protection aircraft nacelle fire extinguishment the aircraft-weather interface severe weather wind shears and turbulence clear air turbulence and lightning are among the topics covered Fire impact management through fire resistant materials technology development is emphasized J M S

N78-29056*# National Aeronautics and Space Administration
 Langley Research Center Langley Station Va

SUMMARY OF NASA LANDING-GEAR RESEARCH

Bruce D Fisher Robert K Sleeper and Sandy M Stubbs /In
 its CTOL Transport Technol 1978 1978 p 773-804 refs

Avail NTIS HC A18/MF A01 CSCL 01C

Research relative to tire tread powered-wheel taxiing air cushion landing systems and crosswind landing gear is discussed J M S

N78-29057*# National Aeronautics and Space Administration
 Langley Research Center Langley Station Va

NOISE PREDICTION TECHNOLOGY FOR CTOL AIRCRAFT

John P Raney /In its CTOL Transport Technol 1978 1978
 p 805-818 refs

Avail NTIS HC A18/MF A01 CSCL 20A

The application of a new aircraft noise prediction program to CTOL noise prediction is outlined Noise prediction is based on semiempirical methods for each of the propulsive system noise sources such as the fan the combustor the turbine, and jet mixing with noise-critical parameter values derived from the thermodynamic cycle of the engine Comparisons of measured and predicted noise levels for existing CTOL aircraft indicate an acceptable level of accuracy J M S

N78-29058*# National Aeronautics and Space Administration
 Langley Research Center Langley Station Va

**FLIGHT EXPERIMENTS TO IMPROVE TERMINAL AREA
 OPERATIONS**

Seymour Salmirs and Samuel A Morello /In its CTOL Transport
 Technol 1978 1978 p 819-847 refs

Avail NTIS HC A18/MF A01 CSCL 01C

A brief description is given of the objectives and activities of the terminal configured vehicle (TCV) program and of some of the airborne facilities A short analysis of some particular problems in CTOL operations in the terminal area is also presented to show how the program's technical objectives are related to the defined problems The test aircraft was flown both manually and automatically with manual monitoring over paths including 130 deg intercepts and 2.0 km and 0.8 km finals Some statistical data are presented from these and other flight profiles designed to address specific terminal area problems An overview is presented of research studies receiving emphasis in the next biennium and their application to the terminal area A description of work undertaken to study the addition of adjacent traffic information to present map displays is also given J M S

N78-29063*# National Aeronautics and Space Administration
 Langley Research Center Langley Station Va

**PROGRESS ON COAL-DERIVED FUELS FOR AVIATION
 SYSTEMS**

Robert D Witcofski /In its CTOL Transport Technol 1978 1978
 p 927-950 refs

Avail NTIS HC A18/MF A01 CSCL 21D

The results of engineering studies of coal-derived aviation fuels and their potential application to the air transportation system are presented Synthetic aviation kerosene (SYN JET-A) liquid methane (LCH4) and liquid hydrogen (LH2) appear to be the most promising coal-derived fuels Aircraft configurations fueled with LH2 their fuel systems and their ground requirements at the airport are identified Energy efficiency transportation hazards and costs are among the factors considered It is indicated that LCH4 is the most energy efficient to produce and provides the most efficient utilization of coal resources and the least expensive ticket as well J M S

N78-29066# British Library Lending Div Boston Spa (England)
**INVESTIGATING AERODYNAMIC TRANSVERSE FORCES
 IN LABYRINTH SEALS IN CASES INVOLVING ROTOR
 ECCENTRICITY**

S S Rosenberg et al 16 Dec 1977 12 p refs Transl into
 ENGLISH from Energomashinostroenie (USSR) v 8 no 8 1974
 p 15-17

(BLL-CE-Trans-7083-(9022 09)) Avail British Library Lending
 Div Boston Spa Engl

Zones of different pressures lying on different sides of a plane passing through the rotor and the stator axes of gas turbines result in transverse forces which are perpendicular to the plane and tend to place the shaft center line in the direction of rotation Such spiral effect causes direct precession of the rotor An air turbine was used to investigate the magnitude of preliminary twisting of the flow in the shrouding seals and the circumferential differential distribution of pressures in the seal in cases where eccentricity exists Measurements reveal a considerable circumferential nonuniformity of pressure and a 75-78 deg deviation from the axial direction A R H

N78-29067*# National Aeronautics and Space Administration
 Ames Research Center Moffett Field Calif

**WIND TUNNEL INVESTIGATION OF COMPUTATIONALLY
 OPTIMIZED VARIABLE CAMBER WING CONFIGURA-
 TIONS**

E G Waggoner (Vought Corp Dallas) H P Haney (Vought
 Corp Dallas) and W F Ballhaus Jun 1978 140 p refs
 Prepared in part by AVRADCOM

(NASA-TM-78479 AVRADCOM-TR-78-32(AM) A-7394) Avail
 NTIS HC A07/MF A01 CSCL 01A

An experimental investigation was performed in the NASA Ames Research Center 14 foot transonic wind tunnel to determine aerodynamic characteristics for several optimized configurations

of a variable camber wing model. Camber and twist distributions which were computationally defined using both subsonic and transonic potential flow analysis codes linked to an optimization technique were verified. The 35 deg swept wing was characterized by multisegmented leading and trailing edge flaps whose hinge lines are swept relative to the leading and trailing edges of the wing. The deflection angles of the flap segments could be varied therefore affording the possibility of optimizing the camber and twist distribution for a given design condition. The test configurations were designed using potential flow analysis codes linked to a constrained minimization technique. Camber and twist distributions were optimized at lift coefficients of 0.2, 0.4 and 0.6 for Mach numbers of 0.6 and 0.9. B B

N78-29068*# National Aeronautics and Space Administration Ames Research Center Moffett Field Calif

CLOSED-FORM EQUATIONS FOR THE LIFT, DRAG, AND PITCHING-MOMENT COEFFICIENTS OF AIRFOIL SECTIONS IN SUBSONIC FLOW

Roger L Smith Aug 1978 58 p refs Prepared in cooperation with the US Army Aviation Research and Development Command St Louis Mo
(NASA-TM-78492 AVRADCOM-TR-78-15(AM) A-7464) Avail NTIS HC A04/MF A01 CSCL 01A

Closed-form equations for the lift, drag, and pitching moment coefficients of two dimensional airfoil sections in steady subsonic flow were obtained from published theoretical and experimental results. A turbulent boundary layer was assumed to exist on the airfoil surfaces. The effects of section angle of attack, Mach number, Reynolds number, and the specific airfoil type were considered. The equations were applicable through an angle of attack range of -180 deg to +180 deg, however, above about + or - 20 deg, the section characteristics were assumed to be functions only of angle of attack. A computer program is presented which evaluates the equations for a range of Mach numbers and angles of attack. Calculated results for the NACA 23012 airfoil section were compared with experimental data. J A M

N78-29069# Massachusetts Inst of Tech Cambridge Aero-physics Lab

A STUDY OF THE LIFT-TO-DRAG RATIO CAPABILITY OF CARET WING WAVERIDERS M S Thesis Interim Scientific Report

Marshall D Solomon Mar 1978 217 p refs
(Contract F44620-76-C-0049)
(AD-A053691 TR-200 AFOSR-78-0758TR) Avail NTIS HC A10/MF A01 20/4

A simple model of the off design caret wing flow field which includes the effects of an upper expansion surface, skin friction, and base drag is proposed. Based on this approximate model, calculations of the lift coefficient, drag coefficient, and lift-to-drag ratio as functions of body geometry, incidence, Mach number, and Reynolds number are made, and the dependence of the aerodynamic coefficients on these variables is identified. A test matrix covering a wide range of caret wings and flight conditions is employed in a search for wings with high lift-to-drag ratio. Caret wing performance is then compared to that of delta wing. Lift-to-drag ratios as high as 6.5 for 5 percent thick wings at free stream Mach number and Reynolds number of 2.0 and 10,000,000 were found. This performance is similar to that of delta wings. However, significantly higher caret wing lift-to-drag ratios could be achieved by replacing the blunt base with an afterbody, thereby reducing the base drag. Author (GRA)

N78-29072# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt Brunswick (West Germany) Abt Theoretische Aerodynamik

CALCULATION OF PRESSURE DISTRIBUTION, FORCES AND MOMENTS FOR THE FIGHTER CONFIGURATION IAE 60 BY PANEL METHOD

V G Torregiani and S R Ahmed Oct 1977 29 p refs
(DLR-IB-151-77/13) Avail NTIS HC A03/MF A01

Preliminary results of inviscid calculations of the pressure distribution, forces and moments for the fighter plane configuration IAE 60 are presented. The symmetrical case without yaw is

considered for the incompressible flow regime and calculations were performed for two angles of attack. Experimental results are available only for total lift and pitching moment - qualitative agreement was obtained between these and the theoretical results. The results were obtained using the panel method developed by DFVLR. ESA

N78-29073# National Aerospace Lab Amsterdam (Netherlands) Fluid Dynamics Div

INVESTIGATION OF THE UNSTEADY AIRLOADS ON WING-STORE CONFIGURATIONS IN SUBSONIC FLOW

J W G vanNunen, R Roos, and J J Meijer 12 Sep 1977 12 p refs Presented at the AGARD Fluid Dyn Panel Symp on Unsteady Aerodyn, Ottawa, 26-28 Sep 1977, and at the 4th JTCC Aircraft/Stores Compatibility Symp, Ft Walton Beach Fla, 12-14 Oct 1977. Sponsored by Air Mater Directorate (RNLAf).
(NLR-MP-77025-U) Avail NTIS HC A02/MF A01

A description and results are given of an extensive research program set up to determine the unsteady aerodynamic loading on oscillating wing-store configurations. It is shown that the tools developed in the course of the program allow for a more accurate prediction of the unsteady air forces introduced by wing mounted stores. Author (ESA)

N78-29074# National Aerospace Lab Amsterdam (Netherlands) Fluid Dynamics Div

INVESTIGATIONS OF THE TRANSONIC FLOW AROUND OSCILLATING AIRFOILS Ph D Thesis - Tech Hogeschool Delft, Neth

H Tjardema 21 Oct 1977 136 p refs
(NLR-TR-77090-U) Avail NTIS HC A07/MF A01

Exploratory wind tunnel experiments in high-subsonic and transonic flow on a conventional airfoil with oscillating flap and a supercritical airfoil oscillating in pitch are described. In the analysis of the experimental results, emphasis is placed upon the typical aspects of transonic flow, namely the interaction between the steady and unsteady flow fields, the periodical motion of the shock waves, and their contribution to the overall unsteady airloads. Special attention is paid to the behavior of the supercritical airfoil in its shock-free design condition. Moreover, it is discussed to what extent linearization of the unsteady transonic flow problem is allowed if the unsteady field is considered as a small perturbation superimposed upon a given mean steady-flow field. Finally, the current status of unsteady transonic flow theory is reviewed and the present test data are used to evaluate some of the recently developed calculation methods. Author (ESA)

N78-29077# Naval Air Development Center Warminster Pa Aircraft and Crew Systems Technology Directorate

POWERED INERTIA REEL RETRACTION DURING EJECTION Final Report, 1 Jun 1977 - 30 Nov 1977

Kenneth Miller, Alan Cantor, and William Ward 20 Apr 1978 34 p
(AD-A054157 NADC-78055-60) Avail NTIS HC A03/MF A01 CSCL 06/7

The purpose of this program was to determine the potential effectiveness of upper torso restraint afforded by PIR (Powered Inertia Reel) actuation at inception of the ejection stroke. This program was jointly funded by the Navy and Air Force, and the results are applicable to the Navy A-7 and the Air Force A-10 aircraft escape systems. Twelve tests were conducted on the NADC Ejection Tower to compare dummy responses for six sets of tests with initial conditions of PIR retraction being varied in each set (one test with retraction, one without). A number of the tests were duplicated in order to demonstrate repeatability of results. It was demonstrated that the tested PIR is not effective in overcoming ejection loads imposed on the dummy during the onset phase of the catapult stroke. Author (GRA)

N78-29082*# Boeing Vertol Co Philadelphia Pa
RESEARCH REQUIREMENTS TO REDUCE CIVIL HELICOPTER LIFE CYCLE COST

Stephen J Blewitt Aug 1978 58 p refs
(Contract NAS1-13624)
(NASA-CR-145379) Avail NTIS HC A04/MF A01 CSCL 01C

The problem of the high cost of helicopter development production operation and maintenance is defined and the cost drivers are identified Helicopter life cycle costs would decrease by about 17 percent if currently available technology were applied With advanced technology a reduction of about 30 percent in helicopter life cycle costs is projected Technological and managerial deficiencies which contribute to high costs are examined basic research and development projects which can reduce costs include methods for reduced fuel consumption improved turbine engines airframe and engine production methods safety rotor systems and advanced transmission systems A R H

N78-29083*# Boeing Vertol Co Philadelphia Pa
CIVIL HELICOPTER DESIGN AND OPERATIONAL REQUIREMENT

Kenneth T Waters Aug 1978 52 p refs
(Contract NAS1-13624)
(NASA-CR-145377 D210-11278-1) Avail NTIS
HC A04/MF A01 CSCL 01C

Design and operational requirements and other factors that have a restraining influence on expansion of the helicopter market are discussed The needs of operators users pilots and the community at large are examined The impact of future technology developments and other trends such as use energy shortages and civil and military helicopter requirements and development is assessed Areas where research and development are needed to provide opportunities for lowering life cycle costs and removing barriers to further expansion of the industry are analyzed A R H

N78-29084# Lockheed-California Co Burbank
GENERAL AVIATION AIRPLANE STRUCTURAL CRASH-WORTHINESS USER'S MANUAL VOLUME 2 INPUT-OUTPUT, TECHNIQUES AND APPLICATIONS
Final Report

Max A Gamon Gil Wittlin and William L LaBarge Feb 1978 183 p refs
(Contract DOT-FA75WA-3707)
(AD-A054317 LR-28307-Vol-2 FAA-RD-77-189 2-Vol-2) Avail NTIS HC A09/MF A01 CSCL 01/2

A comprehensive description of program KRASH is provided Included in this volume of the user's manual are the following sections (1) user's guide (2) math model development (3) KRASH data requirements and (4) typical model arrangements This volume was established in such a manner that it can readily be updated as more data becomes available The subject matter contained within each section can be expanded or revised as necessary without affecting the other sections Each section contains its own numbering system which facilitates the task of updating the document G Y

N78-29085# Lockheed-California Co Burbank
GENERAL AVIATION AIRPLANE STRUCTURAL CRASH-WORTHINESS USER'S MANUAL VOLUME 3 RELATED DESIGN INFORMATION **Final Report, Jun 1976 - Feb 1978**

Feb 1978 121 p refs
(Contract DOT-FA75WA-3707)
(AD-A054266 LR-28307-Vol-3 FAA-RD-77-189 3-Vol-3) Avail NTIS HC A06/MF A01 CSCL 01/2

General information is presented in this report to assist the general aviation airplane industry designer in developing improved structural crashworthiness designs This report is initiated for the purpose of providing the General Aviation Manufacturers Association (GAMA) members with the basis for understanding the types of procedures methods and data that are available with regard to structural crashworthiness The information presented in this volume is intended to compliment the KRASH Users Manual (Volume 1) as well as other analytical or test methods that are applicable to structural crashworthiness design G Y

N78-29086*# Kansas Univ Center for Research Inc Lawrence Flight Research Lab

A THEORETICAL INVESTIGATION OF GROUND EFFECTS ON USB CONFIGURATIONS **Final Report**

C Edward Lan Aug 1978 130 p
(Contract NsG-1139)
(NASA-CR-157355 CRINC-FRL-281-3) Avail NTIS
HC A07/MF A01 CSCL 01C

A theoretical wing-jet interaction theory is presented for predicting the ground effects for upper surface blowing configurations The formulation predicts the variation of circulation forces and jet reaction forces in ground proximity as a function of ground height The predicted results agree well with available experimental data It is shown that the wing-alone theory is not capable of predicting the ground effect for USB configurations Author

N78-29087# Air Force Flight Dynamics Lab Wright-Patterson AFB Ohio

DIGITAL SIMULATION OF FLEXIBLE AIRCRAFT RESPONSE TO SYMMETRICAL AND ASYMMETRICAL RUNWAY ROUGHNESS **Final Report, Sep 1975 - Aug 1976**

Anthony G Gerardi Aug 1977 83 p refs
(AF Proj 1367)
(AD-A053588 AFFDL-TR-77-37) Avail NTIS
HC A05/MF A01 CSCL 01/5

A method has been developed for determining the dynamic response of a flexible aircraft to runway roughness during takeoff or constant speed taxi The equations that formulate the mathematical model have been programmed for a CDC 6600 digital computer and uses a Calcomp plotter for part of the program output Three sets of runway elevation data are input to provide a forcing function at each landing gear Three runway profiles measured at Washington National Airport runway 36 were used to represent a typical commercial asymmetric profile Three lines of profile were analytically generated to represent traversing a 1-cos dip at a 45 degree angle of approach Several aircraft have been simulated with this program each during a takeoff and a constant speed taxi The data used to simulate the airplanes (McDonnell Douglas C-9A Boeing 727-100, and an AMST) and the runway profile data used, are included in the appendix of this paper Comparison of simulated results to limited experimental data was good Peak vertical acceleration levels at the pilot's station were within 14% The effect of the asymmetry of a profile on pilot's station vertical acceleration was significant providing the asymmetry of the profile was significant Author (GRA)

N78-29088# Purdue Univ Lafayette Ind Project Squid Headquarters

PROCEEDINGS OF THE WORKSHOP ON ENGINE-AIRFRAME INTEGRATION SHORT-HAUL AIRCRAFT

S N B Murthy May 1977 485 p refs Conf held at the Naval Acad Annapolis Md
(Contract N00014-75-C-1143 Proj SQUID)
(AD-A053417 SQUID-PU-R1-78) Avail NTIS
HC A21/MF A01 CSCL 01/3

The principal concerns in the development of air-breathing propulsion it is generally agreed are fuel availability engine-airframe-control integration life-cycle reliability and environmental problems In several respects integration presents the most challenging problems from the point of view of future airplanes especially those in which multi-mission capability maneuverability and special flight characteristics are demanded Within the framework of military aircraft technology short-haul carriers with V/STOL capability constitute one of the important classes of airplanes requiring urgent development Integration problems are especially severe in this class of airplanes, and the solution of those problems largely determines the success of the airplanes to meet the projected mission objectives This workshop was devoted to a discussion of the current status the scope for developments and the needs in research in the general area of integration problems in short-haul V/STOL problems The Workshop was attended by about 63 persons who came from various institutions such as universities industries government laboratories and research funding agencies GRA

N78-29089# Boeing Vertol Co Philadelphia Pa
HEAVY LIFT HELICOPTER - ADVANCED TECHNOLOGY COMPONENT PROGRAM - ROTOR BLADE **Final Report, Jul 1971 - Jul 1975**

Sep 1977 237 p refs
(Contract DAAJ01-71-C-0840)
(AD-A053423 USAAMRDL-TR-77-41) Avail NTIS
HC A11/MF A01 CSCL 01/3

This report reviews the development of the Model 301 Heavy Lift Helicopter rotor blade. It describes the design structural analysis testing and manufacturing process of the HLH rotor blade. Author (GRA)

N78-29091# Army Test and Evaluation Command Aberdeen Proving Ground Md

AIRCRAFT MILITARY UTILITY AND FUNCTIONAL TESTS Final Report

Roy L Miller 31 Jan 1978 19 p Supersedes MTP-7-3-518 MTP-7-3-021 MTP-7-3-520
(AD-A053617 TOP-7-2-511 MTP-7-3-518 MTP-7-3-021 MTP-7-3-520) Avail NTIS HC A02/MF A01 CSCL 01/3

This document identifies testing methods and techniques necessary to determine the degree to which Army fixed-wing and rotary-wing aircraft meet the functions and performance requirements stated in the requirements documents. The procedures contained here cover testing relating to the weight and balance ground handling aircraft configuration, system configuration aircraft performance and operational characteristics and compatibility with related equipment. Author (GRA)

N78-29092# Air Force Aero Propulsion Lab Wright-Patterson AFB Ohio

AIRCRAFT HAZARD DETECTION AND CONTROL UTILIZING AN AIRCRAFT DATA ACQUISITION SYSTEM Final Technical Report, Jul 1970 - Jul 1974

Duane G Fox Dec 1977 87 p refs
(AD-A054416 AFAPL-TR-77-77) Avail NTIS
HC A05/MF A01 CSCL 01/2

This report summarizes the results of an in-house program which demonstrates the feasibility of using an aircraft multiplexed data acquisition system for on-board aircraft hazard detection and control. The hazards of primary interest are fire explosion overheat smoke and explosive vapors. Hazard control involves system shutdown as well as activation of extinguishing systems and other active protective systems. This program involves both concept formulation and the design of breadboard hardware to demonstrate these concepts. Advanced aircraft will have multiplexed data acquisition systems with central computers for a variety of applications. Hazard detection is shown to be a small part of the total aircraft data system requirements. It is shown that hazard detection subsystem complexity and cost are reduced by using a data system and computer on a time-shared basis. Author (GRA)

N78-29093# Naval Air Engineering Center Lakehurst NJ
TECHNICAL DATA REQUIREMENTS FOR SHIPBOARD AND SHOREBASED VERTICAL/SHORT TAKEOFF AND LANDING V/STOL AIRCRAFT

W R Clarke and F C Briggs Jr 26 Apr 1978 68 p Revised
(AD-A054102 NAEC-AWS-571-REV-A) Avail NTIS
HC A03/MF A01 CSCL 01/3

This document defines the V/STOL aircraft technical data requirements for the Naval Air Systems Command and the Naval Air Engineering Center. The information and data shall cover both shipboard and shorebased operational areas of compatibility. Data submitted provides a central source of information to support the mission assignments with respect to shipboard suitability ship/aircraft compatibility aircraft spotting studies aircraft proposal evaluation and aviation safety. GRA

N78-29094# Boeing Vertol Co Philadelphia Pa
HLH DRIVE SYSTEM Final Report

J C Mack Sep 1977 455 p refs
(Contract DAAJ01-71-C-0840)
(AD-A054024 USAAMRDL-TR-77-38) Avail NTIS
HC A20/MF A01 CSCL 13/9

This report summarized the total Heavy Lift Helicopter Drive System Advanced Technology components (ATC) program. The program included the establishment of design criteria the development testing of advanced technology components the integration of these components into flight-weight full-scale HLH transmissions and the testing of the transmissions. The aft rotor and engine combining transmissions with associated drive shafting were designed built and tested. The transmission required to power the forward rotor was studied in the ATC program and was detail designed and fabricated under a later HLH prototype program. GRA

N78-29095# McDonnell Aircraft Co St Louis Mo

SUMMARY OF LANDING GEAR INITIAL FLAWS Interim Report, Sep 1976 - Aug 1977

W T Fujimoto and J P Gallagher Wright-Patterson AFB Ohio AFFDL Dec 1977 11 p
(Contract F33615-76-C-3133)
(AD-A054048 AFFDL-TR-77-125) Avail NTIS
HC A02/MF A01 CSCL 01/3

This report briefly summarizes the results of a field survey conducted by AFFDL and McDonnell Douglas at Ogden ALC (Hill AFB) 21-24 September 1976. The objective of the survey was to identify crack-like damage that had resulted in structural failures in landing gear components. This survey was based on depot metallurgical reports from 1971 to August 1976 and discussions with Ogden (ALC) depot maintenance engineering personnel and laboratory metallurgists. Author (GRA)

N78-29096# National Aerospace Lab Amsterdam (Netherlands) Structures and Materials Div

ASSESSMENT OF SERVICE LOAD EXPERIENCE USING AIDS-RECORDED DATA

J B deJonge and D J Spiekhout 5 Apr 1977 34 p refs
Presented at the 9th ICAF Symp Darmstadt West Ger 11-13 May 1977
(NLR-MP-77011-U) Avail NTIS HC A03/MF A01

Inspection periods and safe service lives of transport aircraft are based on an assumed average design load experience. Actual service loads may deviate appreciably from these assumptions. Fatigue related load data may be obtained on a routine basis from aircraft integrated data system recordings. The system in use by KLM, SAS and Swissair for their Boeing 747s is described and the importance of careful data quality checking is stressed. Examples illustrate the highly relevant information with regard to aircraft usage and loading environment that may be obtained. Author (ESA)

N78-29097# Air Force Inst of Tech Wright-Patterson AFB Ohio School of Engineering

THE DESIGN OF AN OPTIMUM ALPHANUMERIC SYMBOL SET FOR COCKPIT DISPLAYS M S Thesis

Larry F Bush Dec 1977 108 p refs
(AD-A053447 AFIT/GE/EE/77-11) Avail NTIS
HC A06/MF A01 CSCL 01/4

The purpose of this study was to design an alphanumeric symbol set with improved legibility which could be implemented as a standardized set for cockpit displays. Pattern recognition theory was applied in which the two-dimensional discrete Fourier transform was used to obtain the feature space for each symbol. Spatial lowpass filtering techniques were employed and a decision rule was used based on the maximum nearest prototype Euclidian distance between symbols. A symbol change algorithm was developed in which symbols were moved away from their two closest neighbors in the transformed domain. Lincoln/Mitre, a highly legible font was used as the initial prototype set. A new alphanumeric symbol set was designed with 18 changed symbols that had an overall greater distance spread between nearest neighbor symbols. The Lincoln/Mitre and a new test set were psychophysically tested with results indicating a 9.5% better performance for the changed symbols over the original Lincoln/Mitre symbols. Author (GRA)

N78-29098# Arinc Research Corp Annapolis, Md

AVIONICS PLANNING GUIDANCE EXECUTIVE SUMMARY Annual Report

Apr 1978 23 p refs
(Contract F04606-76-A-0087)
(AD-A054719) Avail NTIS HC A02/MF A01 CSCL 01/3
This document presents guidance for the development acquisition and support of Air Force avionics systems for the period FY 1978 through FY 1981. It relates threat and mission area analysis results to an avionics investment and support strategy.
Author (GRA)

N78-29099* General Electric Co Cincinnati Ohio Aircraft Engine Group
CORE COMPRESSOR EXIT STAGE STUDY VOLUME 1 BLADING DESIGN Design Report, Oct 1976 - Apr 1977
D C Wisler Dec 1977 67 p refs
(Contract NAS3-20070)
(NASA-CR-135391, Doc-R77AEG400-Vol-1) Avail NTIS HC A04/MF A01 CSCL 21E

A baseline compressor test stage was designed as well as a candidate rotor and two candidate stators that have the potential of reducing endwall losses relative to the baseline stage. These test stages are typical of those required in the rear stages of advanced highly-loaded core compressors. The baseline Stage A is a low-speed model of Stage 7 of the 10 stage AMAC compressor. Candidate Rotor B uses a type of meanline in the tip region that unloads the leading edge and loads the trailing edge relative to the baseline Rotor A design. Candidate Stator B embodies twist gradients in the endwall region. Candidate Stator C embodies airfoil sections near the endwalls that have reduced trailing edge loading relative to Stator A. Tests will be conducted using four identical stages of blading so that the designs described will operate in a true multistage environment.
A R H

N78-29100* National Aeronautics and Space Administration Lewis Research Center Cleveland Ohio
EFFECT OF AIR TEMPERATURE AND RELATIVE HUMIDITY AT VARIOUS FUEL-AIR RATIOS ON EXHAUST EMISSIONS ON A PER-MODE BASIS OF AN AVCO LYCOMING O-320 DIAD LIGHT AIRCRAFT ENGINE VOLUME 1 RESULTS AND PLOTTED DATA
Michael Skorobatchkyi, Donald V Cosgrove, Phillip R Meng, and Erwin E Kempe Jr Jul 1978 109 p refs
(NASA-TM-73507-Vol-1 E-8916-2) Avail NTIS HC E06/MF A01 CSCL 21E

A carbureted four cylinder air cooled O-320 DIAD Lycoming aircraft engine was tested to establish the effects of air temperature and humidity at various fuel-air ratios on the exhaust emissions on a per-mode basis. The test conditions include carburetor lean out at air temperatures of 50, 59, 80 and 100 F at relative humidities of 0, 30, 60 and 80 percent. Temperature humidity effects at the higher values of air temperature and relative humidity tested indicated that the HC and CO emissions increased significantly while the NOx emissions decreased. Even at a fixed fuel air ratio, the HC emissions increase and the NOx emissions decrease at the higher values of air temperature and humidity.
B B

N78-29101* Boeing Aerospace Co., Seattle Wash
PROPULSION/FLIGHT CONTROL INTEGRATION TECHNOLOGY (PROFIT) DESIGN ANALYSIS STATUS
Christopher M Carlin and William J Hastings Jul 1978 415 p refs
(Contract NAS4-2391)
(NASA-CR-144875) Avail NTIS HC A18/MF A01 CSCL 01C

The propulsion flight control integration technology (PROFIT) program was designed to develop a flying testbed dedicated to controls research. The preliminary design analysis and feasibility studies conducted in support of the PROFIT program are reported. The PROFIT system was built around existing IPCS hardware. In order to achieve the desired system flexibility and capability additional interfaces between the IPCS hardware and F-15 systems were required. The requirements for additions and modifications to the existing hardware were defined. Those interfaces involving the more significant changes were studied. The DCU memory expansion to 32K with flight qualified hardware was completed

on a brassboard basis. The uplink interface breadboard and a brassboard of the central computer interface were also tested. Two preliminary designs and corresponding program plans are presented.
J A M

N78-29102* Boeing Aerospace Co., Seattle Wash
PROPULSION/FLIGHT CONTROL INTEGRATION TECHNOLOGY (PROFIT) SOFTWARE SYSTEM DEFINITION
Christopher M Carlin and William J Hastings Jul 1978 351 p
(Contract NAS4-2391)
(NASA-CR-144876) Avail NTIS HC A16/MF A01 CSCL 01C

The Propulsion Flight Control Integration Technology (PROFIT) program is designed to develop a flying testbed dedicated to controls research. The control software for PROFIT is defined. Maximum flexibility, needed for long term use of the flight facility is achieved through a modular design. The Host program processes inputs from the telemetry uplink, aircraft central computer, cockpit computer control and plant sensors to form an input data base for use by the control algorithms. The control algorithms, programmed as application modules, process the input data to generate an output data base. The Host program formats the data for output to the telemetry downlink, the cockpit computer control and the control effectors. Two applications modules are defined - the bill of materials F-100 engine control and the bill of materials F-15 inlet control.
L S

N78-29103* General Electric Co Cincinnati Ohio Aircraft Engine Group
LONG-TERM CF6 ENGINE PERFORMANCE DETERIORATION EVALUATION OF ENGINE S/N 451-380 Final Report
W H Kramer and J J Smith Aug 1978 112 p
(Contract NAS3-20631)
(NASA-CR-159390) Avail NTIS HC A06/MF A01 CSCL 21E

The performance testing and analytical teardown of CF6-6D engine serial number 451-380 which was recently removed from a DC-10 aircraft is summarized. The investigative test program was conducted inbound prior to normal overhaul/refurbishment. The performance testing included an inbound test, a test following cleaning of the low pressure turbine airfoils and a final test after leading edge rework and cleaning the stage one fan blades. The analytical teardown consisted of detailed disassembly inspection measurements and airfoil surface finish checks of the as-received deteriorated hardware. Aspects discussed include the analysis of the test cell performance data, a complete analytical teardown report with a detailed description of all observed hardware distress and an analytical assessment of the performance loss (deterioration) relating measured hardware conditions to losses in both specific fuel consumption and exhaust gas temperature.
A R H

N78-29104* General Electric Co Cincinnati Ohio
DESIGN OF IMPACT-RESISTANT BORON/ALUMINUM LARGE FAN BLADE
C T Salemm and S A Yokel Jul 1978 93 p refs
(Contract NAS3-21041)
(NASA-CR-135417) Avail NTIS HC A05/MF A01 CSCL 21E

The technical program was comprised of two technical tasks. Task 1 encompassed the preliminary boron/aluminum fan blade design effort. Two preliminary designs were evolved. An initial design consisted of 32 blades per stage and was based on material properties extracted from manufactured blades. A final design of 36 blades per stage was based on rule-of-mixture material properties. In Task 2 the selected preliminary blade design was refined via more sophisticated analytical tools. Detailed finite element stress analysis and aero performance analysis were carried out to determine blade material frequencies and directional stresses.
L S

N78-29105* Pratt and Whitney Aircraft Group East Hartford Conn Commercial Products Div
EFFECT OF STEADY FLIGHT LOADS ON JT9D-7 PERFORMANCE DETERIORATION

A Jay and E S Todd 9 Jun 1978 103 p refs
(Contract NAS3-20632)
(NASA-CR-135407 PWA-5512-24) Avail NTIS
HC A06/MF A01 CSCL 21E

Short term engine deterioration occurs in less than 250 flights on a new engine and in the first flights following engine repair, while long term deterioration involves primarily hot section distress and compression system losses which occur at a somewhat slower rate. The causes for short-term deterioration are associated with clearance changes which occur in the flight environment. Analytical techniques utilized to examine the effects of flight loads and engine operating conditions on performance deterioration are presented. The role of gyroscopic, gravitational, and aerodynamic loads are discussed along with the effect of variations in engine build clearances. These analytical results are compared to engine test data along with the correlation between analytically predicted and measured clearances and rub patterns. Conclusions are drawn and important issues are discussed.

AR H

N78-29106# Westinghouse Electric Corp Pittsburgh Pa
Advanced Energy Systems Div
NUCLEAR BI-BRAYTON SYSTEM FOR AIRCRAFT PROPULSION STUDY Final Report, 1 Jul 1977 - 31 Jan 1978
R E Thompson B L Pierce R Calvo, J A Christenson and
H D Coe Mar 1978 107 p refs
(Contract F33615-77-C-0116)
(AD-A054672 WAES-TNR-234) Avail NTIS
HC A06/MF A01 CSCL 21/5

Parametric and reference system definition studies were performed with respect to a new concept for a nuclear aircraft propulsion system. Also studied was a possible method for increasing the payload of a nuclear powered aircraft during wartime. The Bi-Brayton system concept for nuclear propulsion of aircraft has been examined and found to be feasible. The system has been shown to be one which minimizes the component developments required and one which can make effective use of reactor technologies that already exist. Cycle variants and component characteristics were parametrically evaluated and a reference system defined. Weight estimates indicate that with optimized reactor and shielding the total powerplant and fuel weight for the Innovative Aircraft Design Study Task 2 reference aircraft could be reduced from that predicted for a NuERA liquid metal cooled reactor system coupled to an open Brayton cycle turbofan engine. The Bi-Brayton system combined with a compact gas-cooled (NERVA derivative) reactor was found to be a desirable system for nuclear aircraft propulsion and is recommended for consideration in any further studies of nuclear propelled aircraft. GRA

N78-29107# Georgia Inst of Tech Atlanta School of
Aerospace Engineering
NOISE SUPPRESSION IN JET INLETS Interim Scientific Report, 1 Feb 1977 - 31 Jan 1978
Ben Zinn William L Meyer and William A Bell Feb 1978
76 p refs
(Contract F49620-77-C-0066 AF Proj 2307 Grant NSF
GK-42159)
(AD-A054173, AFOSR-78-0696TR) Avail NTIS
HC A05/MF A01 CSCL 21/5

This report summarizes the work performed during the first year of a research effort to determine the sound fields associated with jet engine inlet configurations. A solution approach for axisymmetric bodies based upon the integral formulation of the wave equation has been developed. This solution approach circumvents the uniqueness problems which normally occur at certain frequencies when straight forward solutions of the integral equation are obtained. A numerical method and a computer program for solving for the acoustic field associated with general inlet configurations and boundary conditions have also been developed. To evaluate the numerical method computed and exact results are compared for a sphere and a finite length cylinder. For continuous boundary conditions the agreement is within ten per cent over a range of nondimensional frequencies from one to ten. For discontinuous boundary conditions the numerical errors increased by a factor of two. This report presents

results for a given inlet configuration and the computed and exact solutions are shown to agree to within ten per cent over the nondimensional frequency range from one to ten.

Author (GRA)

N78-29108# Mechanical Technology Inc Latham N Y
TURBINE ENGINE ROTOR DYNAMIC EVALUATION VOLUME 2 ENGINE AND TEST RIG BALANCING Final Report, 1 Apr 1976 - 1 Nov 1977
J Davis J Tessarzik and R A Rio Jan 1978 52 p refs
(Contract F33615-75-C-2035)
(AD-A054533, MTI-76TR41-Vol-2 AFAPL-TR-76-81-Vol-2)
Avail NTIS HC A04/MF A01 CSCL 21/5

As an extension of the original AFAPL Contact for determining the rotor-dynamics characteristics of eight jet engines within the Air Force inventory Mechanical Technology Incorporated performed balancing demonstrations to show the applicability of combining dynamic characteristics and advanced balancing techniques to effectively reduce the vibration of production type machinery. Trim balancing procedures were performed on the TF30 TF41 and F100 jet engines which are currently in use on military aircraft. A very sensitive high-speed experimental test apparatus called the Rub Rig was also used to show the benefits of multiplane-multispeed balancing using influence coefficients. All the balancing operations were highly successful, and showed the potential for using this type of balancing system to increase manpower productivity, reduce operating cost, and to provide a precision balanced rotor for production or laboratory use. Author (GRA)

N78-29110# Stanford Univ Calif Dept of Aeronautics
and Astronautics
EFFECT OF CHORDWISE FORCES AND DEFORMATIONS AND DEFORMATIONS DUE TO STEADY LIFT ON WING FLUTTER Interim Report, 1 Apr 1977 - 31 Mar 1978
William Newsome Boyd Dec 1977 260 p refs
(Grants NGL-05-020-243)
(AD-A053640 SU-DAAR-508 NASA-CR-156945
AFOSR-78-0856TR) Avail NTIS HC A12/MF A01 CSCL
01/3

This investigation explores the effects of chordwise forces and deformations and steady-state deformation due to lift on the static and dynamic aeroelastic stability of a uniform cantilever wing. Results of this analysis are believed to have practical applications for high performance sailplanes and certain RPVs. The airfoil cross section is assumed to be symmetric and camber bending is neglected. Motions in vertical bending fore-and-aft bending and torsion are considered. A differential equation model is developed which included the nonlinear elastic bending-torsion coupling that accompanies even moderate deflections. A linearized expansion in small time-dependent deflections is made about a steady flight condition. The stability determinant of the linearized system then contains coefficients that depend on steady displacements. Loads derived from two-dimensional incompressible aerodynamic theory are used to obtain the majority of the results, but cases using three-dimensional subsonic compressible theory are also studied. The stability analysis is carried out in terms of the dynamically uncoupled natural modes of vibration of the uniform cantilever. GRA

N78-29111# Army Engineer Waterways Experiment Station
Vicksburg Miss
AIRFIELD PAVEMENT SMOOTHNESS REQUIREMENTS Final Report
Walter J Horn Nov 1977 132 p refs
(DA Proj 4A7-62719-AT-40)
(AD-A050921 WES-TR-S-77-12) Avail NTIS
HC A07/MF A01 CSCL 01/5

This investigation was undertaken to determine the influence of airfield pavement surface roughness upon aircraft operations and to develop more realistic airfield pavement surface smoothness criteria for the construction of new airfield pavements based upon aircraft and aircraft crew operational requirements. Based upon a literature review of previous efforts in the area of pavement roughness, the human response criteria to whole body vibration were selected as the criteria for assessing the severity of aircraft response resulting from ground operations. Field tests

were conducted using instrumented aircraft to measure the acceleration response of the aircraft at three locations within the fuselage during a series of ground operations. The profiles of the test site runways were also measured. The results of these tests provided a direct measure of the influence of a known runway surface on the response of the aircraft system and information for the verification of the computer code used during the subsequent analytical phase of the investigation. Aircraft response data were measured for both the B-52 and the Boeing 727 aircraft. GRA

N78-29112# Naval Air Engineering Center Lakehurst, N.J. Dept of Engineering

DEVELOPMENT OF CORROSION RESISTANT FASTENING SYSTEMS FOR AIRCRAFT CARRIER STEAM CATAPULTS
Final Report, 3 Jun 1975 - 30 Nov 1977

Doreen L. Behmke and Edward Taylor 13 Apr 1978 66 p
(AD-A053656 NAEC-ENG-7945) Avail NTIS
HC A04/MF A01 CSCL 13/5

A square drive recess was found to provide better properties for corrosion prone fasteners than a hex drive. Coating systems were evaluated by long term environmental tests simulating the deck near steam catapults. A thick coating of electroplated nickel and cadmium was found to provide superior protection to fasteners installed in steel or manganese bronze structure. Launch valve studs and nuts with a thick electroplated nickel coating were able to survive laboratory tests at 700 F in a corrosive environment. Inconel 718 alloy fasteners also survived the tests and provided superior properties. Author (GRA)

N78-29113# Naval Civil Engineering Lab Port Hueneme Calif
NANSEN-DRIFT STATION PROJECT REMOTE SEA-ICE RUNWAY CONSTRUCTION Final Report, Dec 1976 - Dec 1977

J. L. Barthelemy Apr 1978 50 p refs
(AD-A054720, CEL-TR-865) Avail NTIS HC A03/MF A01
CSCL 01/5

In the past surface-flooding activities have been confined to areas near major military logistic centers. As a result, techniques developed for sea-ice runway construction relied extensively upon the use of heavy equipment to clear snow and position large stationary pumping equipment. At remote sites such as that planned for the proposed Nansen Drift Station requirements are different. Construction crews will be severely restricted as to their size and number of support equipment available and they may be required to work concurrently at a number of scattered locations. A field-test program conducted by the Civil Engineering Laboratory at Barrow, Alaska during March 1977 added a new dimension to surface-flooding technology. The exercises demonstrated the feasibility and capability of using small lightweight pumps to prepare sections of a sea-ice runway. The water-handling equipment included two modified, highly portable centrifugally driven trash pumps that had undergone preliminary low-temperature testing in the cold-chamber facilities at CEL.

Author (GRA)

N78-29114# National Technical Information Service Springfield Va

AIRPORT DEVELOPMENT SOCIAL AND ECONOMIC EFFECTS A BIBLIOGRAPHY WITH ABSTRACTS Progress Report, 1968 - May 1978

Edith Kenton May 1978 66 p Supersedes NTIS/PS-77/0441
(NTIS/PS-78/0447/9 NTIS/PS-77/0441) Avail NTIS
HC \$28.00/MF \$28.00 CSCL 01E

The reports cited in this bibliography involve many phases of airport development relating to local regions and communities including physical design, planning construction operations policies and impacts. Studies of feasibility, conversion-utilization of military facilities economic impact public attitudes and cost effectiveness are cited. Municipal and rural relations political issues controversies and technical assistance programs are described. This updated bibliography contains 61 abstracts 21 of which are new entries to the previous edition. GRA

N78-29154# Naval Research Lab., Washington D C Polymeric Materials Branch

HIGH PERFORMANCE COMPOSITES AND ADHESIVES FOR V/STOL AIRCRAFT Annual Report, 1 Sep 1976 - 31 Aug 1977

Willard D. Bascom and Luther B. Lockhart, Jr Feb 1978 148 p refs
(WF54593201)
(AD-A054637 AD-E000155 NRL-MR-3721 AR-2) Avail
NTIS HC A07/MF A01 CSCL 11/4

An interdisciplinary program has been undertaken to address the composite and adhesive materials requirements of V/STOL aircraft. The primary tasks are to develop and characterize high modulus high toughness resins with use temperatures of 350 F to 450 F or higher to develop fabrication technology for newly developed resin matrices for graphite-fiber reinforced composites to develop composite failure criteria for design optimization and to establish appropriate quality control parameters. The principle accomplishments during the reporting period have been to obtain commercial sources for the C10 phthalocyanine resin and composite prepreg of this resin with graphite fiber to define the fracture behavior of a variety of commercial and in-house high performance resins to establish quality control methods for the phthalocyanine resins based on nmr spectroscopy, to formulate a polyimide-based resin curable by ionizing radiation and demonstrate that graphite-fiber composites can be fabricated using ionizing radiation and to show that failure criteria for composites determined with small scale test coupons accurately predict failure of flaws in a box-beam substructure. GRA

N78-29188# Science Applications Inc San Diego Calif
MIXING AND COMBUSTION IN HIGH SPEED AIR FLOWS Interim Report, 1 Dec 1976 - 31 Mar 1978

R. B. Edelman Apr 1978 47 p refs
(Contract F49620-77-C-0044)
(AD-A054398 SAI-78-008-WH AFOSR-78-0878TR) Avail
NTIS HC A03/MF A01 CSCL 21/2

This report describes the development of a modular model for the prediction of the performance of sudden expansion burners as a function of the controllable parameters relevant to combustors design. The model is based upon a concept in which the recirculation zone treated as a stirred reactor is coupled to a parabolic boundary layer formulation for the flow outside the recirculation zone. Hydrocarbon oxidation kinetics and turbulent kinetic energy models are employed in the model development. In addition to the parabolic-flow and stirred reactor elements a module representing the fuel injection process has been developed. Results of the application of the modular model to the analysis of cold-flow and reacting-flow dump combustor experimental data are described. Author (GRA)

N78-29215# National Aeronautics and Space Administration Lewis Research Center Cleveland Ohio
RUB TOLERANCE EVALUATION OF TWO SINTERED NiCrAl GAS PATH SEAL MATERIALS

Robert C. Bill Jul 1978 12 p
(NASA-TM-78967 AVRADCOM-TR-78-39(PL), E-9726) Avail
NTIS HC A02/MF A01 CSCL 11F

Two strength level variations of sintered NiCrAl (about 40 percent dense) candidate high pressure turbine seal materials were subject to rub tolerance testing against AM 355 steel blade tips. The high strength material (17 N/sq mm tensile strength) showed frictional and radial loads that were 20 to 50 percent higher than those measured for the low strength material (15.5 N/sq mm tensile strength). Measured wear to the AM 355 blade tips was not significantly different for the two sintered NiCrAl seal materials. Wear of the sintered NiCrAl was characterized by material removal to a depth greater than the depth to which blade tips were driven into the seal indicating self-erosion effects. Author

N78-29262# Air Force Aero Propulsion Lab Wright-Patterson AFB Ohio

HYDROGEN CONTENT OF HYDROCARBON FUELS BY A LOW-RESOLUTION NUCLEAR RESONANCE METHOD
Interim Technical Report, 20 Jul - 20 Aug 1977

Honaid D Butler Dec 1977 30 p refs
(AD-A054465 AFAPL-TR-77-61) Avail NTIS
HC A03/MF A01 CSCL 21/4

A low-resolution (wide-line) nuclear magnetic resonance (NMR) technique has been evaluated for the direct nondestructive determination of the hydrogen content of aircraft and missile fuels. The method is rapid and convenient and requires minimal operator training. Accuracy and precision of the results compare favorably with the best microcombustion techniques.

Author (GRA)

N78-29412# Calspan Corp Buffalo N Y
COMPUTER PROGRAM FOR RELAXATION SOLUTIONS OF THE NONLINEAR SMALL DISTURBANCE EQUATIONS FOR TRANSONIC FLOW IN AN AXIAL COMPRESSOR BLADE ROW Interim Scientific Report

William J Rae Apr 1978 79 p refs

(Contract F44620-74-C-0059)

(AD-A053744, CALSPAN-AB-5487-A-3 AFOSR-78-0855TR)
Avail NTIS HC A05/MF A01 CSCL 13/7

This report contains a description of a computer program for calculating the three-dimensional transonic flow through a compressor blade row in the nonlinear small-disturbance approximation and for subsonic values of the inlet relative Mach number at the blade tip. The problem formulation is reviewed briefly following this a description of the program is given together with a listing and sample case.

Author (GRA)

N78-29452# Royal Aircraft Establishment Farnborough (England)

DETERMINATION OF BENDING STRESSES IN A SPUR GEAR TOOTH

Yu N Bunakov May 1977 8 p refs Transl into ENGLISH from Samoletost Tekh Vozdush Flota (USSR) 1967 p 94-96

(RAE-Lib-Trans-1923 BR63467) Avail NTIS
HC A02/MF A01

The bending stress of spur gear teeth is estimated assuming it approximates a cantilever of varying thickness and applying Ritz's variational method for point loading. The stress is determined for a particular case showing the increase near the end of the teeth.

Author

N78-29457# Northrop Corp Hawthorne Calif
WELDBRAZE AIRFRAME COMPONENTS Final Report, 1 May 1976 - 31 Aug 1977

R G Hocker Nov 1977 123 p

(Contract F33615-76-C-5111)

(AD-A054042 NOR-77-115 AFML-TR-77-171) Avail NTIS
HC A06/MF A01 CSCL 01/3

The objective of this program was to develop materials and processes necessary to establish weldbrazing as a useful manufacturing technique that satisfies the structural property requirements for advanced aerospace applications. Several surface preparation methods were evaluated. Spot weld schedules were established for two three and four-layer joints and for three sheet thickness combinations. Methods were developed for determining the proper quantity of filler metal to be placed at the joint edge prior to brazing and for holding the filler metal in place when weldbrazing in the vertical position. Lap-joint properties were determined for Ti-6Al-4V with aluminum filler metals 1100 3003 4043 5052 201 718 AVCO 48 and Al-32Cu-5Ag.

GRA

N78-29458# Timken Co Canton Ohio
TAPERED ROLLER BEARING DEVELOPMENT FOR AIRCRAFT TURBINE ENGINES Interim Report, 8 Oct 1976 - 8 Oct 1977

P S Orvos and G J Dressler Wright-Patterson AFB Ohio AFAPL Dec 1977 97 p refs

(Contract F33615-76-C-2019)

(AD-A054045 AFAPL-TR-77-83) Avail NTIS
HC A05/MF A01 CSCL 13/9

Evaluation tests at speeds to 3.5 million DN were conducted on seven cage designs for high speed tapered roller bearings. These designs were comprised of three geometric and material

options and two surface coatings. The race guided Z-type machined from AISI 4340 steel and silver plated proved to be the best design. Performance tests were conducted on both this design and a roller guided cage. The parametric investigation included effects of speed lubricant viscosity load lubricant distribution and cage design on bearing heat generation (torque). Additionally oil off tests were run to simulate oil supply cessation. Two sets of bearings operating at 1.5 million DN under 2000 lbf thrust load survived for greater than one minute without impairment of rotational capabilities.

Author (GRA)

N78-29509# Lockheed-California Co Burbank
FRACTURE MECHANICS FOR STRUCTURAL ADHESIVE BONDS Final Report, 15 Jun 1975 - 15 Jul 1977

T R Brussat S T Chiu and S Mostovoy Oct 1977 125 p refs

(Contract F33615-75-C-5224)

(AD-A054023 LR-28196 AFML-TR-77-163) Avail NTIS
HC A06/MF A01 CSCL 11/1

Tests and analyses were conducted to develop and demonstrate the fracture mechanics methodology to predict the growth of bondline flaws in adhesively bonded primary aircraft structure. The development and use of a new baseline specimen for testing bondline cracks in combined Modes I and II is described. Specimen development work on other adhesive fracture mechanics specimens including modes I and III is described. Fracture mechanics data for AF-55S adhesive are presented covering fatigue sustained and monotonically increasing loading in laboratory air and hot water in Pure Mode I and mixed Modes I and II. Adhesive bondline crack growth data are presented from fatigue tests of larger structural bonded single lap joints with initial bondline flaws. Techniques are demonstrated for growth monitoring both ultrasonically and by a compliance technique. A fracture mechanics analysis estimate of bondline crack growth rates in these tests is described and the estimated rates are compared to the actual monitored crack growth rates. Based on this work an evaluation is made of fracture mechanics methodology as applied to bondline cracks in adhesively bonded aircraft structure.

Author (GRA)

N78-29699*# Systems Technology Inc Mountain View, Calif
SIMULATION AND ANALYSIS OF WIND SHEAR HAZARD Final Report, Jun 1976 - Oct 1977

John M Lehman Robert K Heffley, and Warren F Clement Dec 1977 156 p refs

(Contract NAS2-8889)

(NASA-CR-157470 AD-A052435 STI-TR-1063-3)

FAA-RD-78-7) Avail NTIS HC A08/MF A01 CSCL 01B

The results of an unmanned simulation and an analysis of wind shear hazard are presented. The study involved the application of mathematical models of four diverse passenger aircraft types ranging from a small STOL commuter aircraft to a jumbo jet and of pilot models appropriate to each flight situation. The hazard to each aircraft was evaluated for both approach and takeoff in three severe wind shear profiles. The effects of varying operational techniques and propulsion system features were investigated and explained with the aid of a simplified linear analysis. No direct correspondence was found between wind shear hazard and aircraft size or type per se. Instead the main factors affecting sensitivity to wind shear were shown to be airspeed flight path regulation and airspeed regulation. Also the shear dependency as modeled in the simulation was found to be important.

Author

N78-29705# Wyoming Univ Laramie Physics and Astronomy

ASSESSMENT OF ATMOSPHERIC CONDENSATION NUCLEI ASSOCIATED WITH JET AIRCRAFT TRAFFIC Annual Report, May 1977 - Apr 1978

D J Hofmann and J M Rosen Apr 1978 36 p refs

(Contract N00014-76-C-0170)

(AD-A054319 CN-8) Avail NTIS HC A03/MF A01 CSCL 04/2

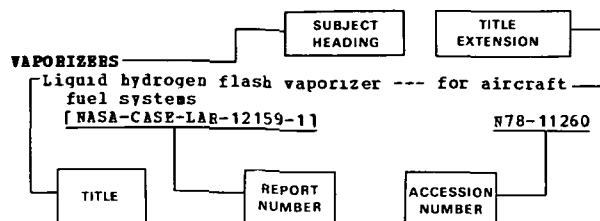
The main goal is to determine the source of atmospheric condensation nuclei (CN) the small particle portion of the atmospheric particle size distribution and to assess the effects of jet aircraft on this particle distribution. In addition, regular measurements of the large sulfate aerosol particles have continued in an effort to assess the source and sink strengths of these particles which are important in the radiative energy balance of the atmosphere. GRA

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Acoustic tests of duct-burning turbofan jet noise simulation: Comprehensive data report. Volume 1, section 2: Full size data
[NASA-CR-135239-VOL-1-SECT-2] N78-28095

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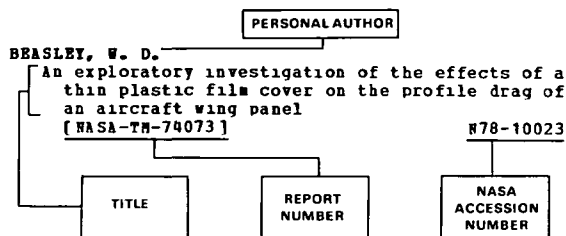
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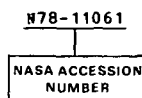
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